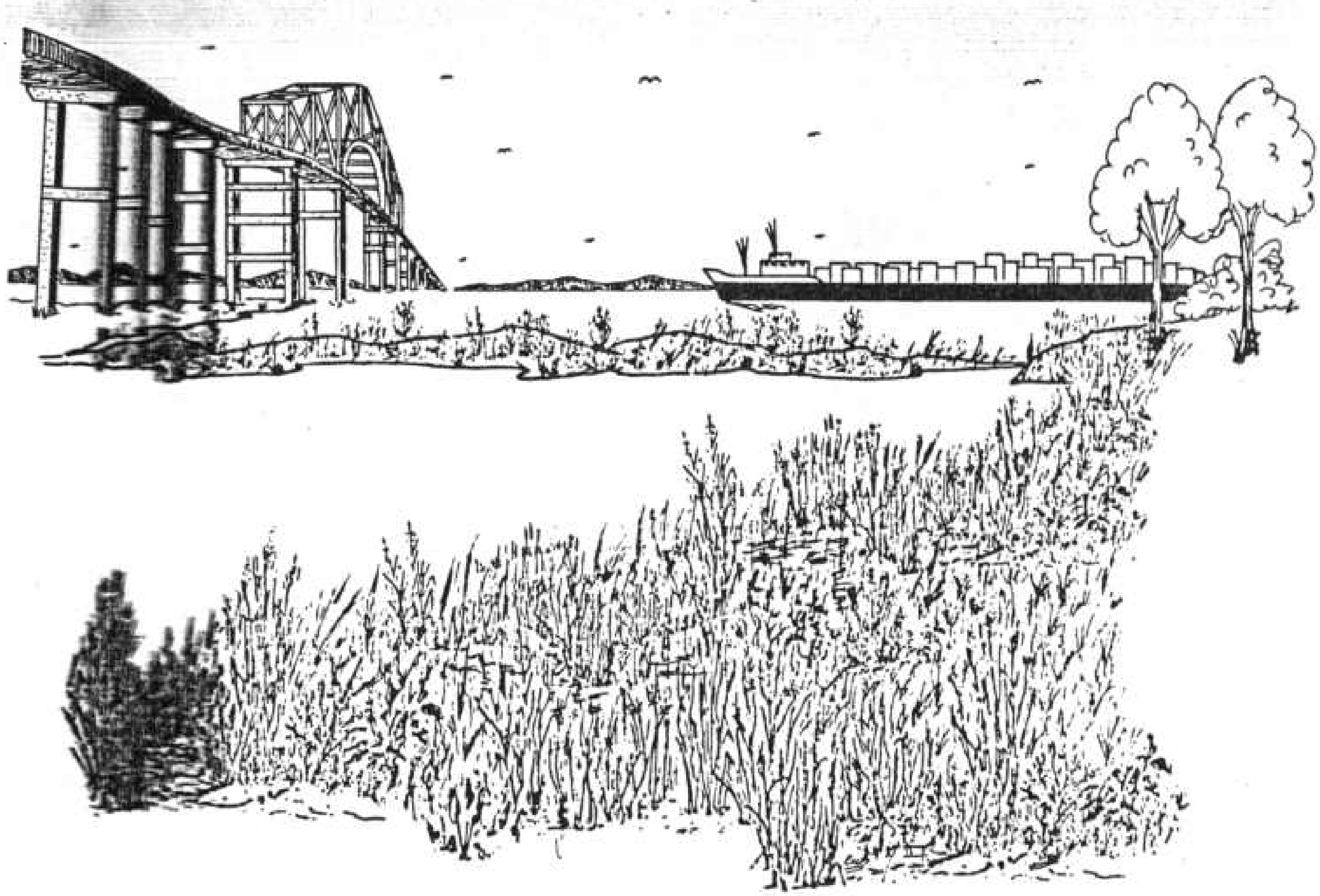
Frank W. Pine



THE BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN

Prepared by:

REGIONAL PLANNING COUNCIL

ECOLOGICAL ANALYSTS, INC.

LAND DESIGN/RESEARCH, INC.

September 1982

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Prepared By

Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Ecological Analysts, Inc.
Hunt Valley/Loveton Center
15 Loveton Circle
Sparks, Maryland 21152

Land Design/Research, Inc.
5560 Sterrett Place
Suite 300
Columbia, Maryland 21044

September 1982

This study is partially funded by a grant from the Office of Coastal Zone Management (NOAA) to the Tidewater Administration, Maryland Department of Natural Resources.

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Regional Planning Council

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Non-Port Industry

Stanley A. Kollar, Jr.
Environment/Ecology

ACKNOWLEDGMENTS

Special thanks should be given to all the members of the Environmental Enhancement Task Force and especially to those who participated on the task force in the early days of the study, giving the initial impetus to the Environmental Enhancement Plan. These people include Edward Stollof, Thomas Dolan, Wayne Klockner, Harley Speir, Alan Clark and David Stout.

Dr. Sarah J. Taylor, Director of the Coastal Resources Division, provided invaluable advice on strategy and procedure and Will Baker, Director of the Chesapeake Bay Foundation, added his ideas for practical implementation.

The authors of the consultant work also deserve special mention for their dedication to the project. These include Dr. Frank Pine, Sarah Wood and Reed Huppman from Ecological Analysts, Inc. along with John C. Hall and Claire Williams from Land Design/Research, Inc.

Mary G. Dolan
Coastal Zone Coordinator
Regional Planning Council
September 1982

EXECUTIVE SUMMARY

The Baltimore Harbor Environmental Enhancement Plan was prepared to address two problems occurring in the harbor: the continuing loss of aquatic habitat and the continuing need for economic development on scarce land in the harbor. Filling has long been allowed for water-dependent uses in the harbor. Only recently has mitigation or compensation been required for resources lost to fill projects. While these requirements have begun to address lost resource values, they have added months of negotiation to the permit process.

The Regional Planning Council, with a grant from the Coastal Resources Division of the Tidewater Administration, prepared this plan with the help of the Environmental Enhancement Task Force. The task force is composed of federal, state and local agency representatives. They guided the work of the consultants, Ecological Analysts, Inc. and Land Design/Research, Inc., as well as that of the Regional Planning Council staff.

The Baltimore Harbor Environmental Enhancement Plan reviews the existing habitat of the harbor, and recommends types of enhancement for each part of the study area. In addition, it recommends the following steps be taken to improve the present process.

1. The Maryland Board of Public Works should consider recommended mitigation projects in lieu of or in addition to monetary compensation for state wetlands, especially in Baltimore Harbor.

2. Mitigation projects for Baltimore Harbor should include projects from the Environmental Enhancement Plan.

3. Where monetary compensation is appropriate, federal and state environmental review agencies should recommend a fee system based on the cost of replacing the resources, giving a comparative analysis of the system with the cost determined by the present formula for computing compensation utilized by the Board of Public Works.

4. Priorities for the Wetlands Acquisition Fund, the Department of Natural Resources Fisheries Research and Development Fund, and/or other funds as appropriate, should include sites and projects from the Baltimore Harbor Environmental Enhancement Plan. Funds should be accumulated and applied to these sites and projects in a logical and timely manner to offset loss of resources due to approved fill projects.

5. The Maryland Board of Public Works should consider leasing as an option instead of a one-time fee for filling open water.

6. If recommendations 3-5 are accomplished, the federal environmental review agencies should accept compensation to the state for use in recognized mitigation projects as fulfillment of federal mitigation requirements for approved fill in Baltimore Harbor.

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0. INTRODUCTION

The national policy emphasis on economic development and streamling of government regulations has given increased importance to land use planning and coastal zone management in port areas. Baltimore Harbor is an important tributary of the Chesapeake Bay, a natural resource of national importance. The harbor has been seriously degraded by man's activities and is only now responding to clean-up efforts initiated a decade ago. The goals of fostering the continued growth of the economy and the continued improvement of aquatic habitat and productivity are often at odds in the Baltimore Harbor, especially when proposed development or expansion is to occur by filling in waters of the state.

The Environmental Enhancement Plan proposes a way to accomodate the fill necessary for economic development while offsetting the lost resources in a logical way by facilitating the existing permit process.

Federal regulations require permits for dredging or filling in the harbor from the U. S. Army Corps of Engineers under Section 404 of the Clean Water Act and Section 10 of the 1899 River and Harbor Act. The State of Maryland requires a wetlands license under the Wetland Act for dredging or filling in the harbor. Both permit processes require mitigation or compensation for fill projects intended for use other than shore erosion control. This includes exploring ways to minimize the fill and compensate in some way for the area that must be filled for development. Developing an acceptable mitigation program is time consuming and can add months or years to the permit process.

This report is concerned with these larger, more complex fill projects which require mitigation. The goal is to remove the time required to develop mitigation from the permit process (when the applicant so chooses) and allow the state to use that applicant's mitigation funds to offset lost resources in the harbor according to an environmental enhancement plan.

It is important to recognize that filling has an impact on three major elements of the Baltimore Harbor aquatic ecosystem: the shore or intertidal zone, the shallow water zone (0-6 feet deep), and the deep water zone (6 feet or deeper). Each of these elements plays a vital role that is integral to the functioning of the other. A loss or improvement in any one element can cause a loss or improvement in the other two elements. Because the intertridal and shallow water areas have sustained the most loss historically, this plan emphasizes enhancement of those areas.

Past filling has greatly reduced the productive shoreline habitat of the harbor as well as eliminating nearly all productive marshes. Of the 1,718 acres of tidal marsh which once existed in the harbor, 647 acres (approximately 38%) were lost between 1942 and 1967. Within the limits of Baltimore City alone, only 19 acres of tidal marsh currently remain along the harbor shoreline, 16 acres of which are reedgrass (Phragmites australis) marsh. Of these 19 acres, 13 are located adjacent to the south side of the Hanover Street Bridge, 1.6 are located at the mouth of the Gwynns Falls, and 3 acres are located along the Patapsco River, east of Patapsco Avenue. The marshes remaining in the harbor have often lost, due to environmental degradation, the diversity of plant species that once provided valuable wildlife habitat. Due to environmental standards and regulations, both water and surface sediment quality are improving in many areas of the harbor, and upland interference is more carefully monitored. These improvements enable some areas to be restored to their former diversity and others to be enhanced significantly.

The potential enhancement projects contained in this report (and in more detailed maps available through the Regional Planning Council) can be constructed either as part of a mitigation effort or as part of parks and other shoreline improvement projects. True enhancement of the harbor can take place only if more of these projects are constructed than those required to compensate for fill projects. The end result will be to amplify the efforts of water quality improvements and create a net benefit to the Chesapeake Bay system.

The Baltimore Harbor Environmental Enhancement Plan is composed of two main elements. The first is a study prepared by Ecological Analysts, Inc, and Land Design/Research, Inc. under the direction of the Environmental Enhancement Task Force (a group of federal, state and local environmental and economic development agency representatives). This study occupies the first two chapters of the plan and details the strengths and weaknesses of the harbor's aquatic habitat, showing what types of enhancement are possible and what areas are appropriate for such activity. Five specific areas were chosen by the Task Force for further analysis, and preliminary site plans were developed. These conceptual plans and the preliminary cost estimates which accompany them give a range of figures which indicate that the cost of replacing resources may be much higher than has been obtained through past compensation.

The second element of the plan (Chapter 3) is an implementation program which recommends a series of steps which could achieve a more equitable balance while reducing permit processing time. Existing, interim and ultimate situations are described as stages in the process of achieving these goals.

1. INVENTORY OF THE HARBOR

1.1 ENVIRONMENTAL CHARACTERISTICS

This section includes a review of the literature on water quality, circulation patterns, sediments, and biota and discussions of the extent of three critical environmental elements: shallow water, "natural" shoreline, and wetlands. The information on water quality, circulation patterns, sediments, and biota is limited to several general harborwide studies (most of which are at least five years old) and a small number of more recent but limited site-specific studies. Most of these studies have been limited to a relatively small number of monitoring or sampling stations and thus produce very general results and conclusions. Such general conclusions may be misleading, on a site-specific basis, in an estuary as large, complex, and dynamic as the Patapsco. Furthermore, there is a general consensus that the environmental quality of the Harbor has improved in recent years, although data are limited. Sediment and water quality, however, are extremely contaminated in portions of the Harbor and will probably remain so for some time.

The general environmental characteristics of Baltimore Harbor and a general descriptive shoreline inventory have been developed through review and analysis of available literature, maps, and aerial photographs. The 11 subdivisions of the Harbor developed by Quirk, Lawler, Matusky Engineers (QLM 1973) have been used throughout the discussion when Harbor location references are made (Figure 1-1). Under the QLM system, Inner Harbor does not refer to the upper end of Northwest Branch as in local colloquial usage. The area referred to as Inner Harbor for purposes of this discussion is shown in Figure 1-1. Maryland Department of Natural Resources (MDNR) wetland maps were used for locating wetlands. Although the wetland upland boundary delineations are reasonably accurate, the validity of the species identifications are questionable depending on the quality of the aerial photographs.

Water Quality

In general the water quality of Baltimore Harbor (defined herein as the 14-mile-long Patapsco Estuary [Figure 1-1]) degrades in the upstream direction from the mouth to the upper branches--Middle Branch and Northwest Branch (Koo 1975). Eutrophication problems, such as algal blooms in the upper reaches of the tributary creeks, occur often and are attributed to poor circulation and very high nutrient concentrations. The major sources of pollution are urban stormwater runoff, industrial waste discharges, and sewage discharges. The Harbor's water quality has shown some improvement since the late 1960s and early 1970s with increased dissolved oxygen (DO) concentrations and reduced fecal coliform bacteria concentrations. The Harbor sediments, however, have accumulated large amounts of contaminants and nutrients (U.S. DOT 1979) and may serve as sources of pollution. The Maryland Environmental Survey (MES 1974) estimated that 60 percent or more of the nitrogen and phosphorous in the Harbor water may be leaching from these bottom sediments.

The most recent, detailed analysis of the water quality of the entire Harbor (Patapsco Estuary) was conducted by QLM in 1973 under contract to the Maryland Environmental Service, Maryland Department of Natural Resources. QLM analyzed water quality data from surveys conducted between May 1968 and August 1971. These analyses were incorporated in the Draft Water Quality Management Plan for the Patapsco and Back River basins (MES 1974).

MES concluded that dissolved oxygen standards would be met in most of the Harbor above the 20-ft depth with the exception of the Upper Middle Branch, Colgate Creek, and Stonehouse Cove (Figure 1-1). Dredging of bottom sediments would be required in these areas in order to improve DO conditions (MES 1974).

Bacteriological standards were not met in the Inner Harbor, Middle Branch (upper and lower), Northwest Branch, Colgate Creek, and Curtis Bay. These standards could be met in the Outer Harbor (below the Key Bridge) except in Bear Creek and other localized areas polluted by urban runoff. Phosphorus concentrations ranged from lows of 0.1-0.4 mg/liter in fall to highs of 0.5-0.9 mg/liter in winter. Although definite spatial differences were apparent, seasonal differences also were found. Higher concentrations were measured in Curtis Bay during spring, in Upper Middle Branch and Bear Creek during summer, and in the Upper and Lower Middle branches and Bear Creek during fall. Total phosphorus concentrations in the Bay upestuary of the Harbor mouth were one to two times higher than the Harbor concentrations in spring and fall and approximately equal to Harbor concentrations in summer. Bay concentrations downestuary of the Harbor were similar to Harbor concentrations in spring, summer, and fall.

Nitrogen concentrations were determined by measuring nitrite-nitrate nitrogen, ammonia nitrogen, and total kjeldahl nitrogen. Organic nitrogen was estimated by subtracting ammonia nitrogen from total kjeldahl nitrogen. The nitrogen concentrations in the Harbor generally were higher than those in the adjacent Bay with the exception of the nitrite-nitrate concentrations during the spring. The low concentrations of nitrite-nitrate nitrogen in the Harbor during summer and fall were attributed to algal uptake. No significant seasonal trends were observed for ammonia nitrogen whereas organic nitrogen was relatively high during fall and winter.

The water quality of the Harbor was defined most recently during the Fort McHenry Tunnel Environmental Assessment (U.S. DOT 1979). These results were compared to those of the MES (1974) study, described above. The Fort McHenry study, however, was limited to the Inner Harbor (above the Key Bridge) where water quality historically has been poorer than in the Outer Harbor. General conclusions of the U.S. DOT study were:

- dissolved oxygen levels have improved considerably, particularly in the fall when the QLM (1973) study observed very low values

- fall pH values were slightly higher in 1978, indicating some improvement

- nutrient (nitrogen and phosphorus) levels were very similar to those described by QLM (1973)

- fecal coliform levels have decreased substantially since 1973

The Maryland water quality standards for temperature, DO, turbidity, and pH were met at all of the stations monitored for the Fort McHenry study (one low pH value, 6.3 versus state standard 6.5, was recorded at one station). The fecal coliform bacteria standard was exceeded at 9 of the 12 stations sampled in the fall and 7 of the 12 spring stations.

During the Fort McHenry study concentrations of heavy metals and other contaminants, not covered under Maryland water quality standards, also were measured, and these concentrations were compared to U.S. EPA criteria. No violations of the chromium criterion were observed. The criterion for cadmium in marine waters (0.005 mg/liter) was met, except at four stations during the fall. Of these, one station was located at Curtis Bay, one was located west of the Dundalk Marine Terminal in the Inner Harbor, and the remaining two were along the south shore of the Lower Middle Branch (Figure 1-1). Mercury concentrations failed to meet the U.S. EPA criterion for the marine environment at all stations.

U.S. EPA water quality criteria for DDT and Mirex (both 0.001 µg/liter) were below the detection limits of the analyses used in the Fort McHenry study. These compounds were detected rarely, if at all, and it was therefore impossible to determine if the waters of the Harbor meet the criteria. PCB concentrations were detected at levels higher than the U.S. EPA criterion throughout the Harbor except at 2 of the 12 stations in spring.

The Fort McHenry study concluded that, although the water quality of the Inner Harbor appears to have improved in recent years, the waters do not yet meet all of the U.S. EPA criteria for the protection of estuarine aquatic life.

Circulation Patterns of Baltimore Harbor

The circulation patterns in Baltimore Harbor (the Patapsco estuary) are complex and variable. The hydrodynamic characteristics of the Harbor include shallow depth (generally <20 feet except in the shipping channels), weak tidal currents, a small mean tidal range, a low longitudinal density (salinity) gradient, and distinct vertical salinity gradient (QLM 1973).

Harbor circulation and flushing studies have documented the existence of a density-induced three-layered circulation pattern (Stroup et al. 1961; QLM 1973). Relatively less dense (low salinity) Chesapeake Bay surface water enters the upper layer of the Harbor and denser (higher salinity) Chesapeake Bay bottom water enters the lower layer of the Harbor. A net upstream flow occurs in both layers. In the third or middle layer (10-25 ft depth), there is a net flow from the Harbor to the Bay. Other factors considered to be of lesser importance were wind-induced motion, tidal flushing, and freshwater runoff. The freshwater flow from the

600 mi^2 Patapsco drainage basin was considered to be relatively insignificant and to supply less than 5 percent on the average of the freshwater flow into the Harbor. The major source of freshwater in the Harbor is the upper layer Bay water that flows into the Harbor from the Upper Bay (QLM 1973).

The Chesapeake Bay Institute of Johns Hopkins University is developing a mathematical model of Baltimore Harbor. Interim conclusions (Boicourt 1979) are that the effects of strong winds are of greater importance than previously supposed. At the heads of the branches and tributary creeks, wind forcing has the major influence on circulation. Preliminary results also indicate that each of the three regions of the Harbor surveyed have very different flushing characteristics.

Such complex and variable circulation patterns may strongly influence water quality on a day-to-day basis and subsequently affect the aquatic biota of the Harbor. The irregular flushing and circulation patterns also may create disjunct pockets of better or poorer water quality within larger areas of relatively uniform water quality.

Sediments

The sediments in Baltimore Harbor have accumulated large amounts of heavy metals, nutrients, and other contaminants (U.S. DOT 1979). Heavy metal concentrations in the Harbor sediments were 3-50 times as great as concentrations in the Chesapeake Bay (Villa and Johnson 1974). Cronin et al. (1974) found sediment copper concentrations in the Inner Harbor 14 times as great as those in the Bay, zinc 3 times as great, and cadmium between 3 and 4 times as great. The distribution of metal concentrations generally corresponds to the location of industrial outfalls.

Metal concentrations varied with location (Figure 1-1) within the Harbor (Villa and Johnson 1974). Northwest Branch sediments contained very high concentrations of chromium, copper, and zinc with lesser amounts of mercury and lead. Middle Branch sediments contained lower concentrations of metals than other areas, although high lead and zinc levels were found. Curtis Bay sediments contained high zinc, copper, and mercury concentrations with lesser amounts of cadmium, chromium, and lead. Isolated areas in Colgate Creek contained lead, copper, mercury, cadmium, zinc, and chromium. Bear Creek sediments were contaminated with chromium and zinc and with slightly lower amounts of lead, mercury, copper, and cadmium. Old Road Bay was heavily contaminated with lead and zinc and also contained high concentrations of chromium and mercury. The Outer Harbor (just east of the Key Bridge) contained high levels of chromium and slightly lower levels of zinc.

Harbor sediments also contained large amounts of nutrients and may be the source of as much as 60 percent of the nitrogen and phosphorus in Harbor waters (MES 1974).

Historical rates of sedimentation are difficult to determine in an area such as Baltimore Harbor which has been subjected to almost continual dredging and filling operations over the years (U.S. DOT 1979). Dredging of channels often was accompanied by spoil disposal in adjacent shallow areas. An analysis of cross-sectional areas of the upper branches, based on U.S. Coast and Geodetic Survey depth data from 1924, 1934, and 1975, yielded an estimated sedimentation rate of 0.018 m/yr (U.S. DOT 1979). This is more than twice as high as estimated recent sedimentation rates for Middle River, Back River, and Furnace Creek (Brush 1979).

The sources of the Harbor sediments are not well understood. The major sediment sources are probably the three major tributaries--the Patapsco, the Gwynns Falls, and the Jones Falls (Brush 1981, personal communication). At the mouth of the Patapsco a large and firm sandy delta extends well into the Harbor, and the Upper Middle Branch has been almost completely silted in by the Gwynns Falls. Much of the Harbor bottom consists of very fine, unconsolidated muck. Such fine material enters the Harbor from the Bay as well as the three major tributaries. The source of most sediment in the Upper Bay is the Susquehanna River.

Biota

In 1975 a biological survey of the Harbor was conducted by the University of Maryland Center for Environmental and Estuarine Studies (CEES) (Koo 1975). The benthic (Pfitzenmeyer 1975), blue crab (Lippson and Miller 1975), and fish (Wiley 1975) populations observed in the Harbor were compared to populations in the Chester River, a reasonably clean tributary to Chesapeake Bay with temperature and salinity patterns similar to those in the Harbor. Fish eggs and larvae (Dovel 1975) were investigated and these results compared to results from studies in other parts of the Bay. Results from the Fort McHenry Tunnel environmental study are incorporated in this section (U.S. DOT 1979), particularly with respect to phytoplankton, zooplankton, and fish populations.

Phytoplankton

Taxonomic, chlorophyll *a*, and productivity sampling conducted during fall 1978 and spring 1979 suggested that the phytoplankton population in the Baltimore Harbor does not differ significantly from that in the waters of the upper Chesapeake Bay or nearby tributary estuaries (U.S. DOT 1979). One Cyanophyta (blue green), four Chlorophyta (green), six Chrysophyta (diatoms), one Pyrrhophyta (dinoflagellate), one Eugleophyta (euglena), and two miscellaneous forms were collected. Chlorophyll *a* values during the spring of 6.1-14.0 milligrams per cubic meter were within the range expected for the surface waters of the Chesapeake Bay; fall values (19.7-77.2 mg/m^3) were relatively high. Primary productivity rates of 60.8-194.7 milligrams carbon per cubic meter were similar to those in other areas of the upper Chesapeake Bay.

Zooplankton

Macrozooplankton samples (collected with a 505-μm mesh net) and microzooplankton (collected with a 153-μm mesh net) from the upper Baltimore Harbor (U.S. DOT 1979) suggested that the pelagic zooplankton population is representative of a reasonably healthy habitat. Copepod species of major importance (*Eurytemora affinis* and *Acartia tonsa*) appeared to be present in very high densities. However, zooplankton species that spend some part of their life cycle resting on the bottom are likely to experience some stress in the Harbor, because of heavily polluted sediment. These include Mysidacea, Amphipoda, Isopoda, and Decapoda. Bottom-feeding fish, therefore, may have a depleted food source in areas that contain heavily polluted sediment.

Benthos

The results of the benthic invertebrate study were considered indicative of the quality of the harbor-bottom environment. A total of 31 species was collected in the Harbor versus 51 in the Chester River. The diversity and abundance of molluscs and crustaceans decreased from Harbor mouth to head. The annelid worms did not follow this pattern, however, showing increased productivity. On the basis of abundance, distribution, biomass, and species diversity of the benthic community, the Harbor was divided into three environmental zones--semihealthy, semipolluted, and polluted (Figure 1-2). In general, all four environmental indicators reflected progressively worsening bottom conditions in the upstream direction. Conditions at the mouth of the Harbor (semihealthy) approximated conditions in the Chester River, although the absence of certain species was considered indicative of some negative environmental qualities. In the semipolluted zone, diversity decreased and one annelid, Limnodrilus, considered an indicator of pollution, increased in abundance. Diversity and abundance decreased markedly in the polluted area of the Harbor, which included the Inner Harbor and its tributaries. Crustaceans and molluscs were very scarce.

The characteristics of the Harbor's benthic community described above and the resultant environmental classification of the Harbor generally reflect the sediment conditions described in Section 1.2.

Blue Crab

The blue crab study revealed the same general trend of progressively worsening environmental conditions from Harbor mouth to head. Crabs were most abundant at the Harbor mouth and catch numbers decreased toward the Inner Harbor. This spatial pattern was reversed in the Chester River, although blue crab were found to be generally declining throughout most of the upper Bay. The frequency of dead crabs in the 1975 Harbor trawl samples also was attributed to the poor quality of the Harbor bottom water and sediment. In the Harbor, 9 percent of the crabs netted were dead, whereas only 0.8 percent of the crabs caught in the Chester River were dead. Many of the crabs caught in Baltimore Harbor had been stained by a black petroleum-like substance. More recent observations have indicated that this staining condition is no longer as apparent.

Fish

The fish survey demonstrated that the Harbor supports a large fish population. White perch was the most abundant species. The fish, however, (especially white perch) generally were inflicted with infections of the lateralis system and deterioration of the fin tissues. These symptoms were attributed to pollution stress since the fish captured in the Chester River were not so affected. Bottom-dwelling species were conspicuously absent in the Harbor, which was attributed to the severe contamination of the Harbor sediments. Fish were scarce in industrial-waste outfall areas. Results reported in the environmental assessment conducted for the Fort McHenry Tunnel Project (U.S. DOT 1979) demonstrated a decline in the white perch population since 1975. The shorezone, however, was considered to "provide a relatively favorable habitat for freshwater, estuarine and anadromous nekton (free swimming) species" (U.S. DOT 1979). It should be noted that this study was restricted to the Inner Harbor (above the Key Bridge).

Fish Eggs and Larvae

Bay tributaries, such as the Harbor, generally function as spawning areas and nurseries for marine and estuarine fishes. The fish eggs and larvae survey indicated that spawning in the Harbor is very limited. Bay anchovy, white perch, alewife, and the blueback herring were identified as possible spawners. Two very common spawners in the Bay's tributaries, striped bass and hogchoker, did not appear to be using the Harbor area. However, the Harbor still functions as a nursery for at least 15 species of fish. Diversity and abundance were more similar to the Chester River in the Inner Harbor areas. Bottom-dwelling species, such as the hogchoker and winter flounder, were again noticeably absent. This probably reflects the very poor bottom conditions described in the preceding section.

Shallow Water Area

Shallow water areas were identified as one of the three critical environmental elements to be considered under the environmental enhancement plan. One of the primary values of estuaries is their function as nursery areas for fish and other aquatic organisms. The intertidal and adjacent shallow water zones are considered the most productive, and therefore most important, nursery habitat (Odum 1971). These areas are also the most subject to the encroachment of man, particularly in an industrialized estuary such as Baltimore Harbor.

For purposes of this study, the shallow water zone was identified as the 0-12 ft portion of the Harbor. A U.S. Coast and Geodetic Survey bathymetric map of the Harbor was the source of depth information. The areas of the shallow water (0-6 and 6-12 ft) and deep water (12 ft plus) zones were determined with a planimeter. Dredged areas adjacent to bulkheading but less than 12 ft in depth were included in the deep water category because they lack the intertidal to subtidal transitional zone that is an integral component of the shallow water zone.

The entire shallow water (0-12 ft) zone comprised approximately 44 percent (15 mi^2) of the Harbor. The 0-6 ft zone comprised approximately 17 percent (6 mi^2) of the Harbor. Although the defined shallow water area was extensive, the shallow water area adjacent to natural shoreline, with uncontaminated bottom sediments and away from outfalls, would be considerably less. Such selective criteria reduce the area of shallow water suitable for certain mitigation techniques.

Natural Shoreline

"Natural" shoreline was identified as a second critical environmental element. The natural shoreline is an important component of the biologically productive shore zone (Clark 1974). Furthermore, the condition of the shoreline will influence the location and selection of mitigation procedures.

For the purpose of this study, natural shoreline is defined as the relatively undisturbed (i.e., nonbulkheaded or riprapped) portions of the land/water interface. As defined herein, natural shoreline includes beaches, vegetated slopes and banks, eroding banks, and vegetated tidal wetlands. The remaining shoreline was divided into altered shoreline and bulkheaded shoreline. Altered shoreline includes areas that are in an obvious state of construction-induced disturbance (i.e., nonvegetated) and riprapped shoreline. Riprap and bulkheading were separated because riprap more closely approximates natural conditions in terms of wave energy dissipation and provision of habitat for intertidal and subtidal aquatic organisms. Because riprap is less subject to catastrophic failure and requires virtually no maintenance, its use thereby reduces disturbance in the shore zone. For these reasons riprap has been encouraged through the Army Corps of Engineers shoreline construction permitting process (Bradley 1981, personal communication).

The extent of each of the three shoreline categories was measured on the Harbor inventory map. Natural shoreline comprised approximately 50 percent (47 miles) of the Harbor's entire shoreline. Altered shoreline comprised 18 percent (17 miles) and bulkheading comprised 16 percent (15 miles). The natural shoreline statistic, however, is probably an overestimate. Small bulkheads along residential waterfronts were difficult to discern on aerial photographs. It is suspected that a large portion of the upper reaches of the tributary creeks are bulkheaded but were incorporated in the natural shoreline category because of insufficient data.

Wetlands

The importance of wetlands (both vegetated areas and shallow water habitat) to the aquatic ecosystem has been well documented (Odum 1961, 1971; Darnell 1967; Clark 1974). These habitats function as nursery grounds for most species of fish and shellfish important to man (Odum 1971) as well as a nutrient source for phytoplankton and detritus feeders which occupy the first trophic level in food chains (Darnell 1967). Unfortunately, wetlands are quite susceptible and vulnerable to construction activities, such as dredging, channelizing, and filling (Darnell 1976). These activities have greatly reduced the acreages of wetlands, particularly tidal marshes, within the Harbor and thereby reduced primary productivity and habitat for fish and shellfish.

The Maryland State Planning Department's (Metzgar 1969) inventory of larger (>5 acres) vegetated wetlands in Baltimore City, Baltimore County, and Anne Arundel County suggests that within the study area there are 63 acres of wetlands in Baltimore City, 555 acres of wetlands in Baltimore County, and 453 acres of wetlands in Anne Arundel County. Acres of wetlands historically lost in these regions (within the study area) total 154, 247, and 246 acres, respectively.

The Regional Planning Council's (RPC 1981b) inventory of all vegetated wetlands in the Harbor revealed actual numbers of wetlands (although aerial photography by MDNR indicated a slightly larger number). Anne Arundel County had the greatest number of wetlands, 104; Baltimore County had the second highest, 79; and Baltimore City had the fewest, 15. Almost all of these wetlands fall either into the brackish high marsh or the brackish low marsh classification. Brackish high marshes often are composed of monotypic zones of giant reed (*Phragmites australis*), cattails (*Typha latifolia* and *T. angustifolia*), three square (*Scirpus* sp.), and marsh elder (*Iva frutescens*). Brackish low marshes have a smaller range of diversity and are frequently dominated by smooth cord grass (*Spartina alterniflora*).

Aerial photography (MDNR 1972) also was used to survey wetland habitats in the Harbor study area, and these have been defined on the Shoreline Inventory Map. (Available on request from the Regional Planning Council.)

Summary

The preceding sections on water quality, sediments, circulation, and biota of Baltimore Harbor were based on the available scientific literature. However, these studies have generally been limited in scope and provide only a partial picture of an estuary as large and complex as the Patapsco. Most of the studies have been limited to less than 25 monitoring stations. Further attempts to accurately characterize the Harbor on the basis of measured physical, chemical, or biological parameters are made more difficult by the complex nature of these processes within the Patapsco estuary. For example, available water quality and sediment information compiled prior to 1977 indicates that Curtis Bay is one of the most polluted areas in the Harbor. A 1977 survey of a small shallow cove in the heavily industrialized area near the mouth of Curtis Creek, however, revealed the presence of a very low density but reasonably healthy biological community (Ecological Analysts 1977). Dissolved oxygen levels also were well above the state minimum standards. The existence of such heterogeneous patches of water is typical of many harbor estuaries (Odum et al. 1974). Furthermore, analysis of different community types or parameters will yield different results. Pfitzenmeyer (1975) classified the Harbor into three health zones on the basis of the benthic community (see Section 1.1.4.1 and Figure 1-2). Because of the sedentary nature of the benthos, analysis of this community type provides a measure of the long-term environmental quality of the Harbor bottom. Analysis of a motile resource, such as the fish population, may result in a different conclusion. Fish can avoid degraded areas and take advantage of temporal and spatial improvements in water quality to exploit food or shelter resources.

On the basis of the CEES biological survey of the Harbor, Koo (1975) concluded that there was biological potential in Baltimore Harbor, although most aquatic organisms in the Harbor were under stress. The

Harbor bottom water and sediments were singled out as the most severely degraded component of the community. Koo also states that "through pollution abatement and habitat improvement, the Harbor may be restored as a viable water body for aquatic resources."

Restoration of the Harbor waters should emphasize areas that are ecologically important. Analysis of the extent of three critical environmental elements (shallow water, natural shoreline, and wetlands) reveal that there is considerable shallow water area and natural shoreline. Wetlands are not extensive, but a number of large, healthy wetlands are present near the mouth of the Harbor and in some of the tributary creeks. All of the three environmental elements decrease in area or extent from the mouth to the head of the Harbor. The Harbor bottom sediments, water quality, and biological diversity generally decrease in quality in the upstream direction also. Hence, prime enhancement sites are more abundant in the Outer Harbor. The scarcity of natural areas in the Inner Harbor and upper branches, however, should be a consideration in the location of enhancement projects.

The extent of the natural shoreline element was the most difficult to quantify; the available data were insufficient for a detailed analysis. Major shoreline alterations were obvious on aerial photos and were often documented elsewhere. Small bulkheading, riprapping, and other bank or shoreline protection techniques used along the private residential waterfronts of the tributary creeks were difficult to discern on aerial photos and were not adequately documented elsewhere. The Research and Management Shoreline (RAMS) database maintained at the Johns Hopkins Applied Physics Laboratory was investigated (the RAMS system is a shoreline alteration monitoring program based on granted shoreline alteration permits), but could not supply data on shoreline alterations prior to 1973 (Bridgeland et al. 1981). The system has incorporated all shoreline alteration permits granted between 1973 and 1979 and is continually updated. The system provides excellent information on shoreline change since 1973 but does not include any pre-1973 analysis of the shoreline. Furthermore, not all granted permits are acted on, and the engineering designs specified in the initial permit application often are modified prior to actual construction.

Although an accurate description of shoreline condition in the tributary creeks would be useful, the typical small private residential waterfront bulkheads, etc., would generally not seriously affect the shallow water zone unless the construction had been accompanied by dredging and filling to increase fastland. In most cases, such structures are designed for erosion control and are fronted by very shallow water and in some cases beaches or mudflats at low tide. Such conditions approximate natural conditions, although energy from wave deflection may contribute to bottom scouring and negatively affect a small portion of the aquatic community.

1.2 SHORELINE INVENTORY

A brief discussion on each Harbor division's existing shoreline conditions follows. Detailed descriptions of existing shoreline conditions are located in the Appendix.

The Northwest Branch of the Patapsco estuary is heavily industrialized and much of the shoreline is bulkheaded. The entire area has been dredged and the water is deep, the minimum depth generally exceeds 10 feet. Water quality is very poor and ship traffic is heavy. Numerous stormwater and industrial discharge outfalls are located along the shoreline. One of the three freshwater sources for the Harbor, the Jones Falls, enters the Harbor at Fallsway and Pratt streets. A large portion of the shoreline was screened from this study because of the shipping activities.

The Upper Middle Branch's shoreline has been altered by human activities; much of the shoreline is retained by riprap which is cluttered with trash and other debris. Potential boat wake problems exist because several private marinas are located near Smith Cove. The Gwynns Falls enters the Patapsco in this section but does not have enough flushing power to clean out the polluted water. Swann Park and Waterview Avenue Park are two publicly owned areas in the Upper Middle Branch.

Approximately one-half of the Lower Middle Branch's shoreline is bulkheaded; the other half is altered shoreline. The bulkheading is concentrated on the northern shore near Port Covington and the MPA's Locust Point marine terminal; the altered shoreline is located around Masonville. The riprapping and altered shoreline does support an occasional wetland. Larger, healthier wetlands border the Patapsco River as it winds through Patapsco Valley State Park. This section of the Patapsco River supports fish ponds and is cleaner than the section located in the Harbor proper.

Much of the Inner Harbor's shoreline is bulkheaded. There are areas that are not and these are showing signs of erosion. Many shipping channels dissect the waters, supporting the heavy ship traffic along the Dundalk Marine Terminal and Canton/Seagirt shoreline. There are small areas of natural shoreline in the Inner Harbor, primarily in the Curtis Creek tributaries, Marley Creek and Furnace Creek. These natural shorelines support many small wetlands and some forested areas. Water quality has shown some improvement in these areas. Small private piers dot the shoreline. Colgate Creek enters the Inner Harbor above Dundalk Marine Terminal; its shoreline is altered with riprap and bulkhead and the water quality is poor.

Four major tributaries enter the Outer Harbor and compose much of the shoreline: Stony Creek, Rock Creek, Bear Creek and Old Road Bay. Much of their shoreline is altered but there are some large stretches of natural shoreline in Stony and Rock creeks. The upper end of Rock Creek, however, is experiencing severe erosion and circulation problems. These natural shorelines have many coves with wetlands at their heads and beds of submerged aquatic vegetation (SAV). The water quality is better in these southern creeks than on the northern side of the Harbor in Bear

Creek and Old Road Bay. These two systems have altered shorelines, particularly around Sparrows Point. Sparrows Point also contributes to the lower water quality on this side of the Harbor. However, wetlands are present in protected coves.

The mouth of the Harbor is predominantly undisturbed natural shoreline. The water quality is good and numerous wetlands (some very large) are found here. There are large stretches of publicly owned land. Black Marsh, Shallow Creek, and Bodkin Creek support relatively healthy biological communities.

2. SITE SELECTION PROCESS

This explanation of the site selection process begins with a discussion of the proposed environmental enhancement activities (Section 2.1) that will be used in Baltimore Harbor. The goals and limitations of the activities are defined. Section 2.2 describes the concept of staging certain mitigation and enhancement activities so as to better ensure their effectiveness. Section 2.3 describes the screening process used to identify those portions of the Harbor not amenable to environmental enhancement for various reasons. Section 2.4 describes the site evaluation processes and presents the criteria used for ranking each site in terms of its potential for each enhancement activity. The ranking criteria are based on the physical, chemical, and biological characteristics of the site. This section also describes the matrix that assigns a numerical ranking value for each site based on the ranking criteria and the enhancement activity.

2.1 IDENTIFICATION OF ENHANCEMENT ACTIVITIES

Specific enhancement activities have been selected for implementation in the Baltimore Harbor. These activities have emphasized both the critical habitats (natural shoreline, shallow water areas, and wetlands) as well as specific problems, such as shore erosion. In general, the enhancement activities have been selected to mitigate for dredge and fill projects which often reduce shallow water shoreline habitats. It should be emphasized that a single activity may mitigate more than one environmental problem and therefore there is some degree of overlap among the different activities. For example, construction of fish reefs may improve the habitat for fish populations as well as serve as a breakwater to reduce shore erosion; or wetland construction may help control shore erosion and trap sediment. Therefore, a single enhancement project may be of broader benefit to the ecosystem than it may initially appear. The enhancement activities, which are described in the following paragraphs, include

1. Wetland construction,
2. Wetland rehabilitation,
3. Shoreline cleanup,
4. Shoreline erosion and sediment control,
5. Submerged aquatic vegetation establishment, and
6. Fish reef establishment are described below.

Wetland Construction

Construction of vegetated wetlands has been selected as an enhancement activity for many reasons. Wetlands are susceptible to dredge and fill operations because of their location and the once popular but ill conceived notion that wetlands have no intrinsic value. Fortunately layment as well as ecologists are now well aware of the sensitivity of wetlands to encroachment by man and the importance of wetlands to the aquatic ecosystem. Wetlands serve as both a nutrient pool and nutrient exporter. Shallow waters surrounding the wetlands provide nursery grounds for many economically important fish; they provide food and shelter for many species of birds; and they serve as a deterrent to erosion. Wetland construction is possible in many areas of the study zone. These areas include shallow water areas, protected coves, dredged material disposal areas, and moderately eroding shore- zones.

Only pollution tolerant species should be selected as propagules for wetland establishment in degraded areas. Establishment of vegetated wetlands in these areas increases biological productivity, isolates polluted sediments, helps trap sediment entrained in the water column, and improves aesthetic value.

Wetland Rehabilitation

Rehabilitation of degraded wetlands can serve the same enhancement function as wetland construction. In some cases, rehabilitation will involve only minimal effort such as removal of debris or the clearing and deepening of tidal creeks which have been filled with sediment or other obstructions. At other sites, a wetland's size or plant species diversity could be increased through plantings.

Re-establishment of tidal flushing in near shore nontidal wetlands is another potential rehabilitation technique. Along much of the southern shore of the Harbor there are a number of nontidal wetland/pond systems which are separated from the Harbor waters by narrow beaches. Geomorphological evidence suggests that most of these systems were once connected to the Harbor but have been closed off by longshore drift (the transport of sediment parallel to the shore). Reconnecting these wetland systems by dredging small channels would significantly increase wetland and protected shallow water habitat in the Harbor at minimal cost. At present, these systems are nontidal and receive water from precipitation, runoff, stormwater drainage discharge and occasional high tide surges, and are probably eutrophic, particularly in late summer. Reconnection to the Harbor would re-establish tidal flushing, increase productivity, and reduce eutrophic conditions. Tidal wetland species would probably rapidly colonize the ponds and increase the vegetated portions of the ponds. Where healthy nontidal wetlands now exist, however, it is not recommended that such efforts be undertaken.

Shoreline Cleanup

Extensive portions of the Harbor shoreline are littered with trash, dilapidated structures, abandoned hulks, and other debris that detract greatly from the appearance of the Harbor. The Maryland Environmental Service recognized this problem in 1974 and recommended the development of a cleanup policy (MES 1974). Cleanup of such debris will not directly benefit the Harbor's biological community but will improve its appearance and contribute to a more healthy image. Although shoreline cleanup should not be considered a separate enhancement activity, removal of old pilings, etc., will often be necessary for other enhancement activities, such as marsh construction, and will help reduce debris that can cause damage and reduced productivity.

Shoreline Erosion and Sediment Control

Shore erosion and sediment control have been lumped together as an enhancement activity because control of shore erosion will cause some reduction in the suspended sediment in the Harbor. The major sources of sediment, however, are the watersheds of the Bay's tributary rivers (Wallace et al. 1970). The most direct sources for the Harbor are the Gwynns Falls, the Jones Falls, and the Patapsco River (see Section 1.1). The types of projects necessary for the control of these sources of sediments are not within the scope of this study. Such projects would involve reducing soil erosion and the construction of stormwater detention ponds upstream.

Shore erosion is a serious problem throughout the Chesapeake Bay (Wallace et al. 1970; ACE 1973). It is a natural process and can be difficult and expensive to control. One additional characteristic of the shoreline erosion process, which can complicate attempts to control the problem, is the accelerated erosion which takes place at the ends of erosion control structures such as bulkheads and riprap. The primary processes causing shore erosion are wave action, tidal currents, and groundwater seepage at the base of bank scarps (ACE 1973). In the Harbor, wave activity generated by wind or ship wakes is the primary erosional force. Factors affecting rates of erosion are shoreline configuration, direction and velocity of prevailing winds, frequency and directions of storms, fetch (the reach of open water over which the winds blow), the patterns of erosion and deposition of the longshore or littoral currents, and the nature of the shoreline material (Wallace et al. 1970). All natural shorelines in the Harbor consist of unconsolidated sediments which are very susceptible to erosion. Wetlands may be as susceptible to shore erosion as fastland in certain situations where wave energy is high.

Shore erosion control measures can be divided into structural and nonstructural. Nonstructural methods consist primarily of planting or encouraging vegetation. Fringe marshes constructed in front of eroding banks can buffer wave action and accumulate sediment through reduction of wave velocity (ACE 1973; Clark 1974). Planting or maintaining upland vegetation buffer strips along the shore edge can retard bank collapse because the vegetated buffer reduces runoff, the plant roots bind the soil, and transpiration reduces the amount of water percolating through the soil and discharging at the base of the bank (Clark 1974). Vegetation buffer strips can also function as sediment traps and reduce the amount of sediment in surface runoff as well as the amount of surface runoff.

Structural erosion control methods include bulkheads, riprapping, and other means of bank or shore armament. Groins and jetties (elongated structures constructed perpendicular to the shore) are designed to trap and accumulate the sediment which is carried by the longshore current and are frequently used to control beach erosion.

Nonstructural erosion control methods are recommended herein as enhancement activities because they can serve a dual function in reducing erosion and suspended sediment as well as provide vital habitat in the

Harbor. In areas exposed to severe wave action, wetland construction incorporated with a protective structure such as a low dike may be recommended.

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) is an important estuarine resource (Stevenson and Confer 1978). SAV species occur in shallow shoreline areas and are generally limited to water less than 10 feet in depth. SAV provides the principal source of food for several species of waterfowl and some fish species. SAV beds are vital habitat for numerous organisms including the larval and/or juvenile stages of blue crab and many commercially important species of fish. SAV beds also function as breeding and spawning areas for numerous species and are used as surfaces for attachment of eggs. SAV removes certain noxious substances from the water, produces oxygen, and is an important detritus source. SAV beds are believed to stabilize bottom sediments and reduce shore erosion. SAV has declined throughout the Chesapeake Bay in recent years and despite considerable research, no undisputed causal factors have been implicated (Stevenson and Confer 1978).

Efforts to re-establish SAV have been few. Reestablishment experiments conducted by the Maryland Department of Natural Resources met with only limited success (Stevenson and Confer 1978). However, planting experiments in areas once supporting SAV may fail because of the existence of the same adverse environmental conditions that originally caused a decline. The existence of SAV beds in the Harbor was documented in a 1978 survey (American University 1978). SAV beds occurred only along the southern shore of the Outer Harbor, whereas SAV also used to occur along the northern shore of the Outer Harbor (Orth and Moore 1981). During the 1978 American University study, one very large bed (approximately 11.5 acres) of redhead grass (*Potamogeton perfoliatus*) and wild celery (*Vallisneria americana*) was found off Marley Neck. The presence of these beds is encouraging and would suggest that proper conditions for SAV growth exist in this area of the Harbor. This may indicate that efforts to establish SAV could be successful at least in this portion of the Harbor.

Artificial Reefs

Artificial fish reefs are elevated structures or mounds of rocks, reinforced concrete honeycomb structures, reinforced fiberglass spirals, pilings, or other rigid materials which are placed on the bottom. Because the reefs project upward from the slower moving bottom waters into the more rapidly cycling water column where nutrients and detritus are entrained, they provide superb habitat for attached filter feeding organisms (Odum et al. 1974). Such hard substrates suitable for attached organisms are of limited extent in Chesapeake Bay. Reefs projecting into the euphotic zone also will support algal populations. These dense growths provide an excellent food source and attract and concentrate fishes from all levels of the food chain. Artificial reefs provide shelter and protection for smaller fish (Stone et al. 1974), and it is these specially designated structures (concrete honeycombs or reinforced fiberglass spirals) that are suggested for future use in the Patapsco estuary. In addition, other specialized reefs, designed specifically tofunction as nursery areas, are being recommended for areas where there is protection from wave action and currents.

Location of artificial reefs should be carefully considered. The bottom must be firm enough to support the structure. In certain areas of the Inner Harbor this may be a problem. For maximum biological utilization the reef should be located such that it is not exposed to long fetches over which prevailing storm winds may blow. Severe storm waves may damage the biological communities and even destroy the reef. Avoidance of any navigational obstruction also must be considered.

Artificial reefs could be used as breakwaters to protect eroding shoreline. This would require building the reef at or close to the mean high water level. Wave action, however, would probably have a somewhat adverse impact on settling organisms and plants on the upper portion of the reef and to be effective may necessitate construction of long, continuous reefs or a series of short reefs that would parallel the shoreline. Such structures may be viewed as a navigational hazard and would have to be carefully located.

2.2 STAGING CONCEPT

In consideration of the concern over the development of certain mitigation approaches in the Baltimore Harbor area, it has been suggested that certain mitigation procedures be staged, i.e., phased in over time so as to allow for the maximum possible environmental improvement in the long run. This is particularly applicable to reef structures, which may not be appropriate in areas that presently are severely degraded. It is recommended, therefore, that the mitigation in areas such as the Middle Branch or Curtis Creek be initiated with shoreline cleanup, erosion control, and fringe marshes. As discharges are reduced and water quality and sediment quality are improved, consideration, in the future, of various types of shallow water reefs may be initiated. Some improvements in water quality have already been achieved (U.S. DOT 1979). Both phosphorus and nitrogen concentrations have been reduced, as well as the suspended solids concentrations through improved regulatory controls such as NPDES permit requirements and improved sedimentation and erosion control laws.

It is important that the type of mitigation recommended for an area have a reasonable chance of success. Since certain types of mitigation will enhance the environment to the point where others may then be initiated, we are recommending that in the site review process in the future, such stepwise approaches to environmental enhancement be seriously considered. Such areas as may be available on the south shore of the Patapsco River east of the Francis Scott Key Bridge are sufficiently clean at this point to allow for the full range of mitigation procedures reviewed in this report. Areas on the north shore outside of the Francis Scott Key Bridge may require improvements in water quality and sediment quality before fish attracting devices will be practical. West of the Francis Scott Key Bridge, there are far more areas that are degraded, particularly with respect to sediment. Therefore, mitigation approaches that would improve shallow water habitat may best be delayed until discharges have been improved or eliminated. Sedimentation and erosion control measures must also be implemented so as to effect an improvement in both water and sediment quality. The development of marshes in some areas of the Inner Harbor may be effective, but the inclusion of fish spawning ponds or reef areas at this time is not recommended.

In conclusion, although the full range of mitigation procedures applies generally throughout the Harbor, some of those measures which relate to bottom-feeding fish, spawning, and nursery development should be considered but delayed until improvements of first stage mitigation procedures have proven effective.

2.3 SCREENING PROCESS

Portions of the Harbor's shoreline are not considered for environmental enhancement projects for various reasons. Three basic criteria were utilized to screen these areas were:

1. Commercial/industrial areas with heavy shipping activity (and areas under construction or proposed for such use)

    - Port Covington east to Fells Point (except for Ferry Bar)
    - Canton/Seagirt
    - Dundalk Marine Terminal
    - Sparrows Point docks
    - Curtis Bay docks
    - Masonville
    - Marley Neck/Chessie disposal area
    - Thom's Cove/Eastalco Pier area
    - Maryland Port Administration property

2. Sites previously selected for mitigation projects

    - the head of the Upper Middle Branch
    - Hawkins Point (Fort Armistead)
    - City Garage
    - Colgate Creek near railroad bridge

3. Areas otherwise excluded

    - Fort McHenry (except for a planned 6.5-6.7 acre wetland under federal ownership and excluded for aesthetic and historical preservation reasons).

The remainder of the Harbor was considered for enhancement projects.

2.4 SITE EVALUATION

Evaluation Criteria

Eight criteria were developed to evaluate the physical, chemical, biological, and other characteristics of the sites in terms of the requirements of the enhancement activities. These ranking criteria are general, and some have greater applicability to one enhancement activity than another.

Criteria are assigned a 1 (bad) or 2 (good), or a 1 (bad), 2 (fair), or 3 (good). The ranking criteria were:

- Water quality
- Sediment quality
- Water depth
- Wind exposure
- Ship wake frequency
- Improvement potential
- Public access
- Ownership

A complete description of the process used to rank sites, as well as the complete matrix, can be found in Appendix A. A summary of the results of the site evaluation process is found in Table 2-1. The sites are presented beginning with the highest score and proceeding to the lowest.

2.5 GRAPHIC IDENTIFICATION OF MITIGATION POTENTIAL

Land Design Research has produced an oversized map delineating specific areas for enhancement activities in the study area. This map is available from the Regional Planning Council on request. Information used in the development of this map was generated by a shoreline inventory of existing conditions in the Baltimore Harbor and the site Evaluation Matrix (Appendix Table A-1). A key accompanying the map explains each enchance- ment activity's symbol. Initially, the appropriateness of the suggested enhancement activity was determined by using existing literature sources.

Therefore, it was necessary to field check each site to investigate the feasibility of the suggested activity. An overview of proposed activities and their locations is presented in Figure 2-1.

2.6 SELECTION OF FIVE SITES FOR IMPLEMENTATION OF ENHANCEMENT ACTIVITIES AND CONCEPTUAL SITE PLANS

Thirty-eight locations in the Baltimore Harbor have been evaluated as sites for enhancement activities (Site Evaluation Matrix Summary - Table 2-1). Of these 38 sites, five sites have been selected by the Environmental Task Force for environmental enhancement activities. The five sites are: (1) the shorelines around Fort Howard and Fort Howard Park, (2) Sollers Point along the shores of the eastern approach to the Key Bridge, (3) the north side of the western approach to the Key Bridge, (4) ponds at Rockwood Beach and Venice-on-the-Bay, and (5) the seven ponds area adjacent to Patapsco Valley State Park. Their locations are given in Figure 2-2.

The preliminary site plans are found at the end of this section (Figures 2-3 through 2-11). These plans define proposed enhancement procedures and may be subject to modification during the final design stage. At this time, site access has not been defined. The following descriptions of the five selected sites do not include discussions pertaining to public access. The Regional Planning Council will provide a discussion concerning access as part of the overall Enhancement Plan.

Each site was selected based on three factors: (1) feasibility, (2) geographical location, and (3) rank. Although every effort was made to use high-ranking sites, this was not always possible. In the case of Fort Howard Park, a second low-ranking site (Fort Howard Medical Center) was included because of its proximity to the Fort Howard Park and its feasibility. The Sollers Point and Hawkins Point sites ranked relatively low, but were included because they represented the most feasible sites within Baltimore City. Both the Patapsco State Ponds and Hog Neck sites ranked near the top of the list.

Preliminary cost estimates were made (Appendix B) and a statement of the cost usage with a brief explanation has been included in the site description below.

Fort Howard (Site 1, Figure 2-3)

Environmental enhancement for the shore zone around Fort Howard involves fish reef establishment, shoreline erosion control (breakwater stabilization), and fringe marsh creation (Figure 2-4). The improved water quality maintained by increased flushing in this area creates a more suitable site for fish reefs. Specific designs must first consider wave energy and substrate conditions, however. The stone revetment and bulkhead enclosing the shoreline is badly in need of repair in specific areas. Repairing these areas will reduce erosion and, in some cases, maintain the wetlands that it is protecting. To enhance nursery habitat for fish and waterfowl, a saltwater fringe marsh has been suggested along the western shore. Its size will be approximately 20-30 feet wide, with riprap breakwater protecting it in front, and have a gentle slope. It is estimated that it will cost between $234,444 and $283,218 to develop the site. The range reflects the need to determine water depths, wave energies, and length of shoreline to be included.

Sollers Point (Site 2, Figure 2-5)

Fringe marsh creation and establishment of fish reefs have been selected as enhancement activities along Sollers Point. The marshes should be saltwater tolerant (Figure 2-4) and constructed in shapes that will enhance their life. Where appropriate, these marshres would be widened to support a more diverse plant population (Figure 2-6). These plans also include riprap in front of marshes exposed to long fetches and could include fish reefs in front of the marsh to reduce wave energy which will provide habitat for larval and juvenile fish. The Toll Authority property adjacent to B.G.& E.'s Sollers Point Plant has a severely eroding bank. The slope may be cut back and hydroseeded to provide stabilization. The estimated cost of this site ranged between $1,455,545 and $1,706,030. The final cost will depend on actual water depths and wave energies. These will affect the size of the stone breakwater required as well as the amount of fill needed.

North Side of the Western Approach to the Key Bridge
(Site 3, Figure 2-7)

Following careful review with the Task Force, the shoreline along the northern side of the west approach was chosen for clean-up and development of a fringe tidal salt marsh. The area, which is owned by the Maryland Toll Facilities Administration, is reasonably well protected, although it may be subjected to ship wakes. For this reason a stone breakwater has been suggested for protection. Before the final design stage is reached, a more extensive field survey should be undertaken to determine

1. actual quantities of fill required for wetland creation,
2. amount of stone required for the breakwater, and
3. the number and types of inlets required for adequate flushing.

The cost estimates range from $115,674 to $138,854 and final costs will depend on the factors listed above.

Hog Neck (Site 4, Figures 2-8 and 2-9)

Two ponds, south of Fort Smallwood Park, have been suggested for habitat improvement. The first (Figure 2-8) is located immediately south of Fort Smallwood. At present, only high or storm tide waters enter the area, but the vegetation is salt tolerant. A cut would be made to facilitate tidal flushing and stone jetties would be placed at the mouth of the cut to prevent siltation. A foot bridge also would be constructed to allow passage along the beach.

The second pond, Hines Pond at Venice-on-the-Bay (Figure 2-9) has been managed by the neighboring community association to provide tidal flushing by Bay waters. The inlet has been lined with stone and a bridge with culvert pipes was constructed. Field observations revealed reduced tidal exchange because of obstructions and siltation of the pipes. To increase the exchange of waters and thereby improve the shallow water habitat of the pond, a reopening of these pipes has been suggested.

In addition, the low energy associated with the pond, its low turbidity (field observation), and shallow depth seem to provide excellent habitat for establishing submerged aquatic vegetation. This has been suggested along the southern shore. The relatively clean waters of the Harbor in this area provide suitable water quality to make fish reef establishment a possibility. The area is subject to high wave energy because of the long fetch in front of the shore so construction of a fish reef first must be designed by an engineer experienced in this field.

The cost estimates for these two concepts range between $33,640 and $34,670 and are dependent primarily upon the amount of stone required.

Patapsco State Ponds (Site 5, Figure 2-10)

The area selected for mitigation in the Patapsco Valley State Park is located north of Belle Grove Road and presently is used by the public for fishing but is severely degraded east of Old Annapolis Road. The ownership of this site is presently private, but is under negotiation for purchase by the state. The mitigation selected for this area involves stabilizing the shoreline (which is in a state of flux) around the three large ponds. Stabilization will be performed by freshwater fringe marsh creation along eroding shores. Creation of a conceptual plan for a freshwater marsh is illustrated in Figure 2-11. A new pond, west of the existing ponds, has been suggested to increase shallow water habitat and provide fill for wetland establishment.

The Maryland Department of Natural Resources (MDNR) has a Master Plan for Patapsco State Park. This plan facilitates public access and utilization of the enhancement activities suggested by the Environmental Task Force, and the proposed activities are intended to tie in with the state's recreation proposals. Other possible mitigation points in this area are the Southwest Area Park and the large mudflats that border the Patapsco River as it enters Baltimore Harbor. Conceptual site plans of these last two areas have not been included in this report, but wetland creation, erosion control, and shoreline cleanup are activities that may be considered for them in the future.

The cost estiamtes range from $1,061,912 to $1,525,024. The final cost will depend upon the quantity of stone required and the amount of fill needed. Both of these requirements will depend on the determination of actual depths of the area recommended for enhancement.

Conclusion

This report has been prepared as a stepping stone to enhancing the ecological environment in an industrialized area. The matrixes developed may be utilized in the future for specific areas of interest and when evaluating a site's potential for habitat improvement. However, there are areas which may need in-depth field observations and designs to determine the extent of a problem and how to improve it. In addition, the water quality of the Baltimore Harbor has shown signs of improvement over the past few years. This should be taken into account when evaluating areas at the head of the Harbor.

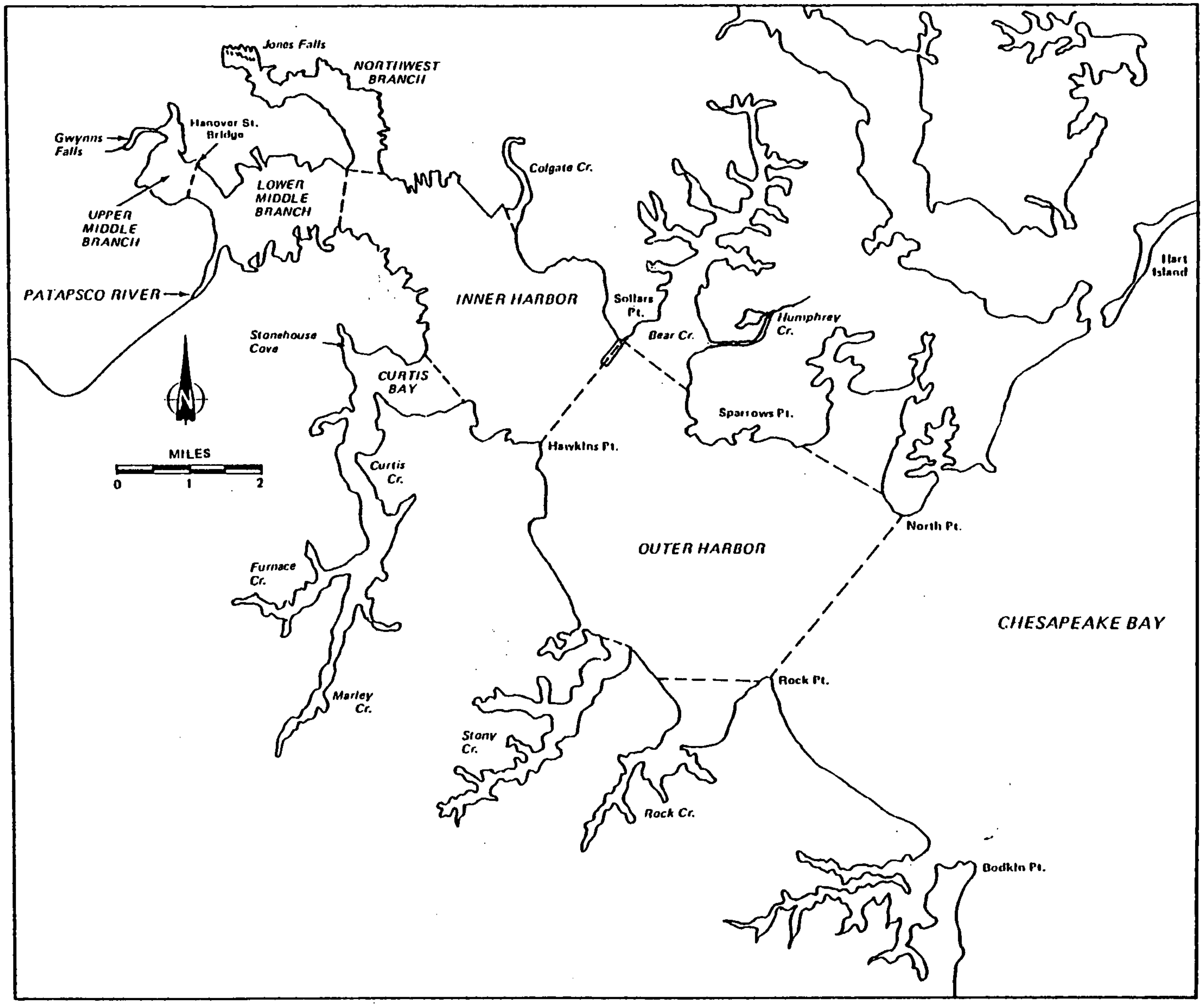

Figure 1-1. Divisions of the Baltimore Harbor based on Quirk, Lawler and Matusky 1973.

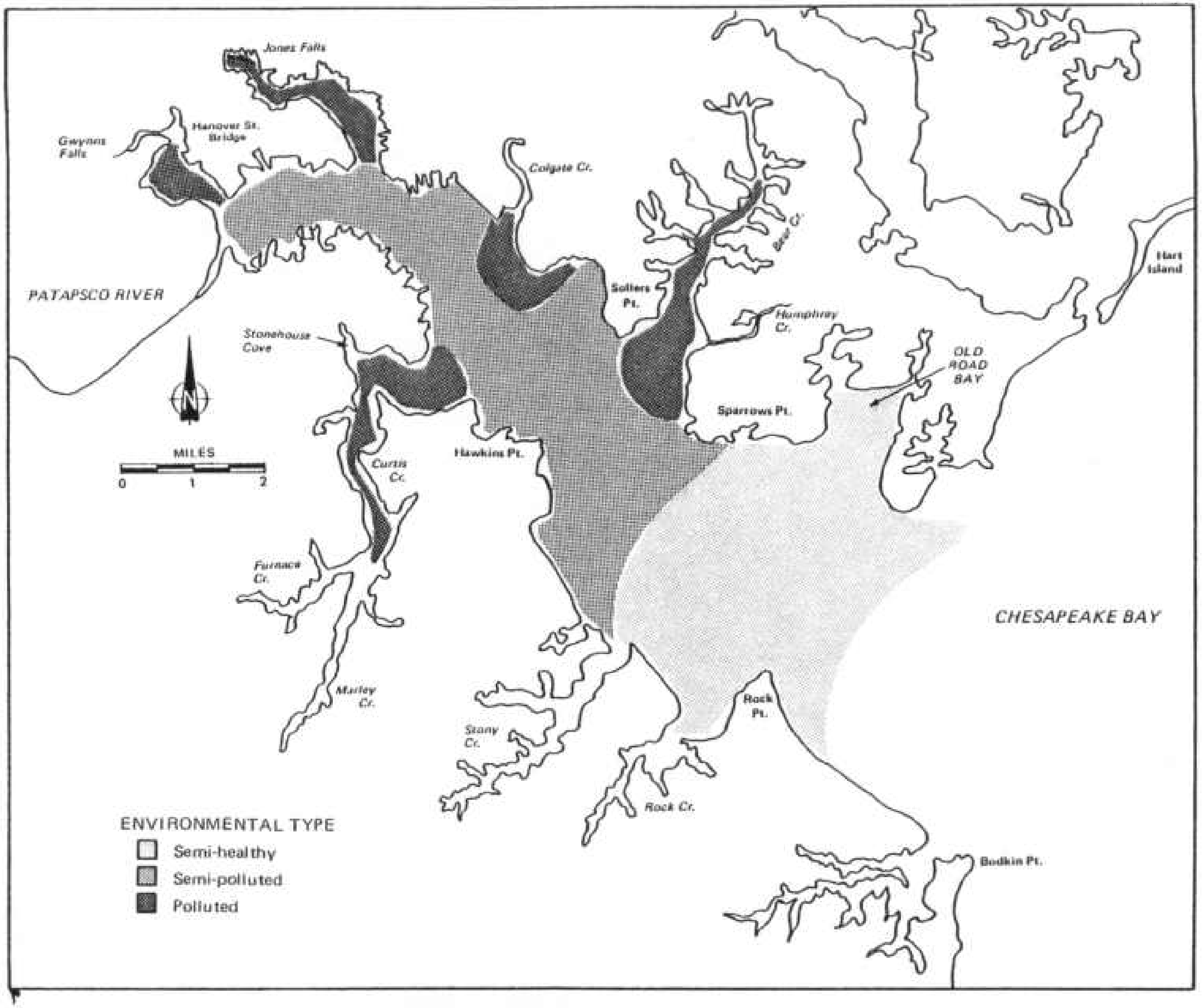

Figure 1-2. Environmental type distributions in the Baltimore Harbor developed from Pfitzenmeyer (1975), based upon the benthic community.

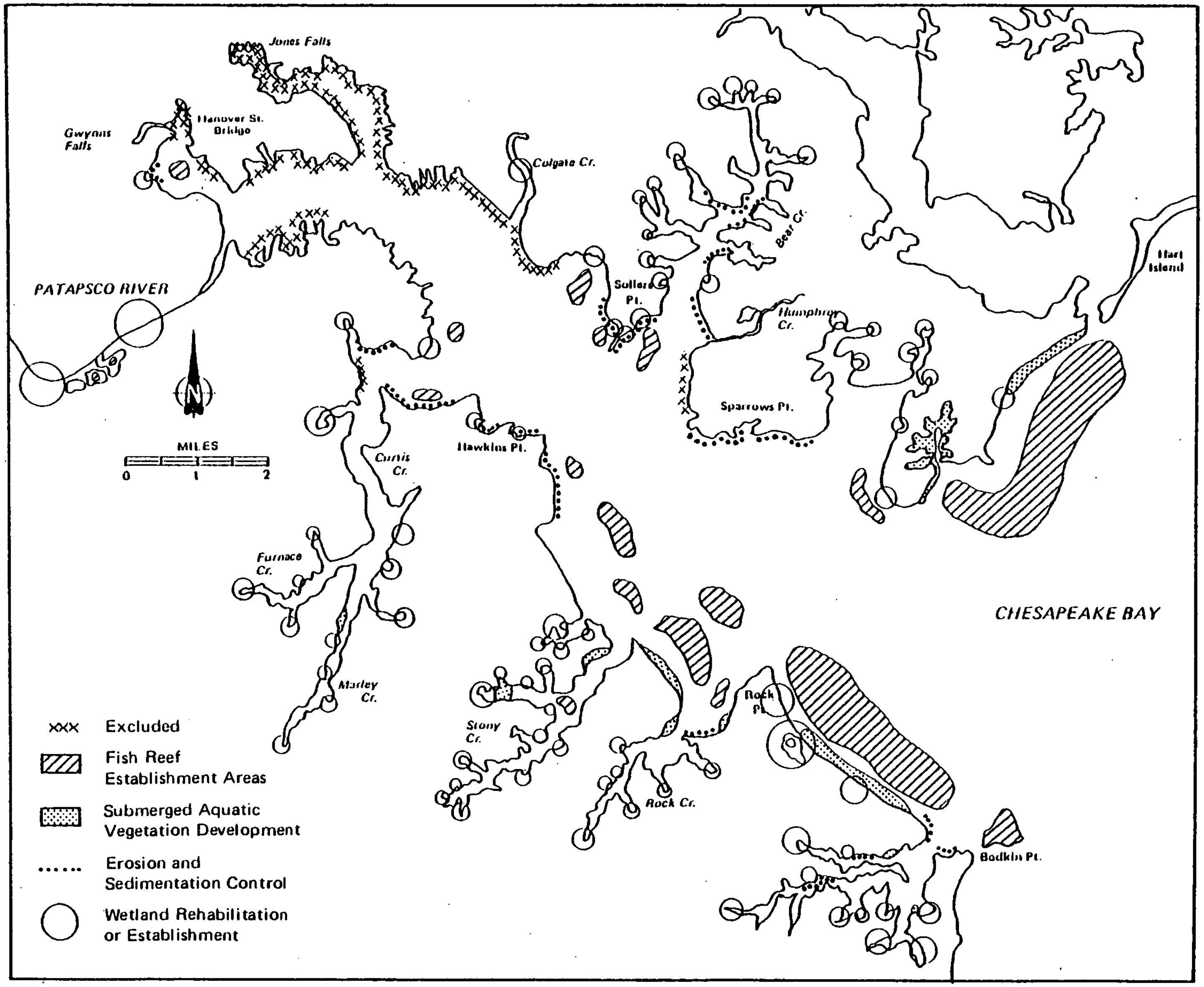

Figure 2-1. Overview of proposed environmental enhancement activities and their locations. (For details, see Proposed Enhancement Activities map, available on request from the Regional Planning Council.)

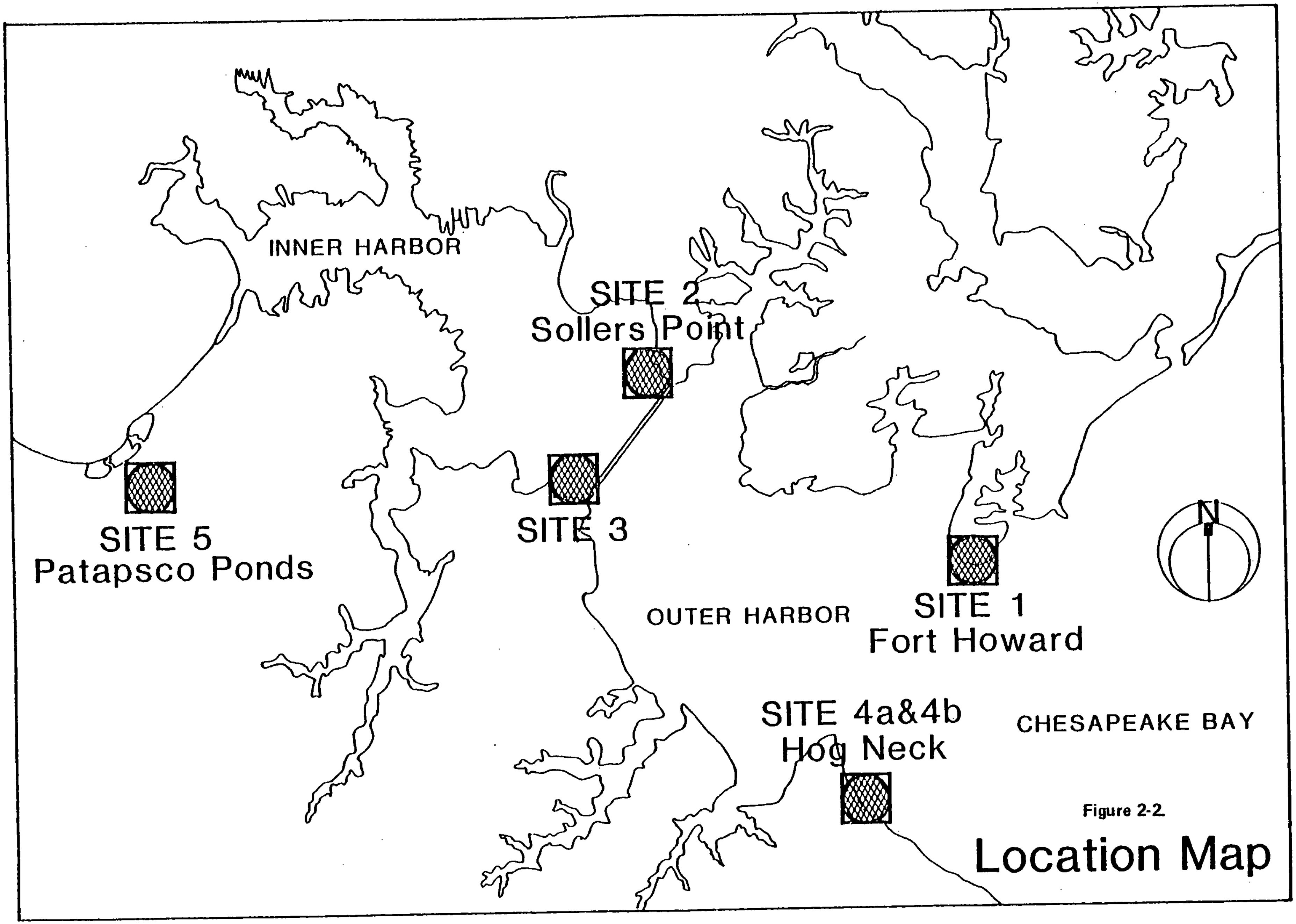

Figure 2-2.

Location Map

TABLE 2-1 SUMMARY OF THE SITE EVALUATION MATRIX (Sites are ranked according to the overall total)

Inventory Reference Number		Wetland Construction	Wetland Rehabilitation	Shore Cleanup	Erosion and Sediment Control	SAV Establishment	Fish Reefs	Overall Total
8	Patapsco State Park	95	94	86	91	94	100	560
33	Fort Howard Park	95	94	86	73	100	93	541
20	Fort Smallwood Park	84-89	08	86	82	94	87-93	521-532(a)
32	Hog Neck	89	88	71	73	100	93	514
35	Black Marsh	89	88	71	73	94	93	508
24	Back Cove and Nabbs Creek (in Stoney Creek)	89	88	71	64-73	94	87-93	493-508(a)
37	Main Creek	89	88	71	73	94-100	87	502-508(a)
23	Stoney Creek	89	94	71	64	94	93	505
38	Bodkin Creek	89	88	71	73	94	80	495
36	Back Creek (A.A. County)	84	88	71	64	94	87	488
29	Lynch Cove	79	76	100	82	76	67	480
15	Furnace Creek	79-84	82	86	64-72	82	73	451-480
28	Bullneck Cove	79	76	100	73	76	73	477
16	Marley Creek	79	82	71	82	82	73	469
30	Head of Bear Creek	74	71	100	91	71	60	467
34	Shallow Creek	84	88	57	55	88	87	459
18	Cox Creek	79	82	71	64	76	80	452
31	Old Road Bay	68-74	86	06	02	76	53-60	436-449(a)
14	Curtis Creek	68	71	86	82	71	67	445
25	Rock Creek and Coves	89-95		71-86	73-82	94	86	414-444(a)
2	I-95 East to Hanover Bridge	79		100	100	76	65	428
27	Clements Cove and Peachtree Cove	79		100	82	76	67	404
19	Stoney Beach and Riviera Beach	79-84		71-86	64-73	76	80	370-399(a)
4	Waterview Avenue Park	68		100	100	65	60	393
12	Dundalk Marine Terminal to Sollers Point	74		86	82	76	73	391
3	I-95 West to (but not including) Waterview Park	68		86	91	71	73	389
17	Brandon Shores	79		71	73	76	87	386
11	Colgate Creek	74		86	82	76	67	385
13	Curtis Bay and Stonehouse Cove	68		86	91	71	67	383

(a) Range indicates that some parameters were variable and appropriateness of a given mitigation approach chnaged (See Table A-1). Rank is based on the upper limit of the range.

TABLE 2-1 (CONT.)

Inventory Reference Number		Wetland Construction	Wetland Rehabilitation	Shore Cleanup	Erosion and Sediment Control	SAV Establishment	Fish Reefs	Overall Total
10	Leading Point to Hawkins Point	79		86	73	71	73	382
9	Harbor Tunnel to Fishing Point	68		86	73	71	73	371
5	Ferry Bar	68		86	82	71	60	367
6	Broening Park and South Baltimore General Hospital	63		86	73	76	67	365
21	Sparrows Point	58		86	91	65	60	360
22	Fort Howard Medical Center	63-68		57-71	82-91	65	60-67	321-362
1	Fells Point to Clinton Street	63		86	81	65	67	362
26	Sollers Point	68		71	64	71	60	334
7	South of Reed Bird Park to Harbor Tunnel	63		71	73	65	47	319

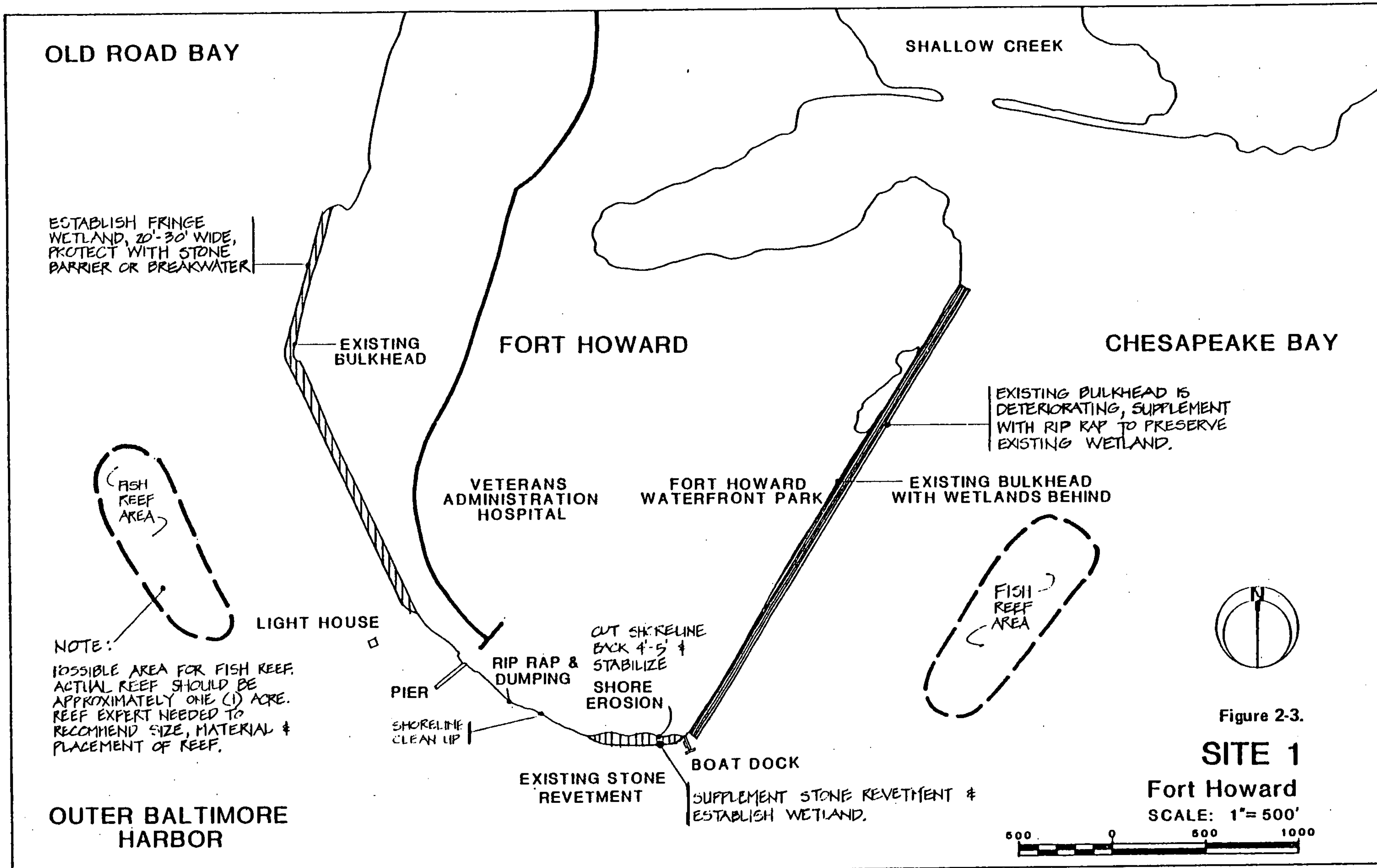

Figure 2-3.

SITE 1

Fort Howard

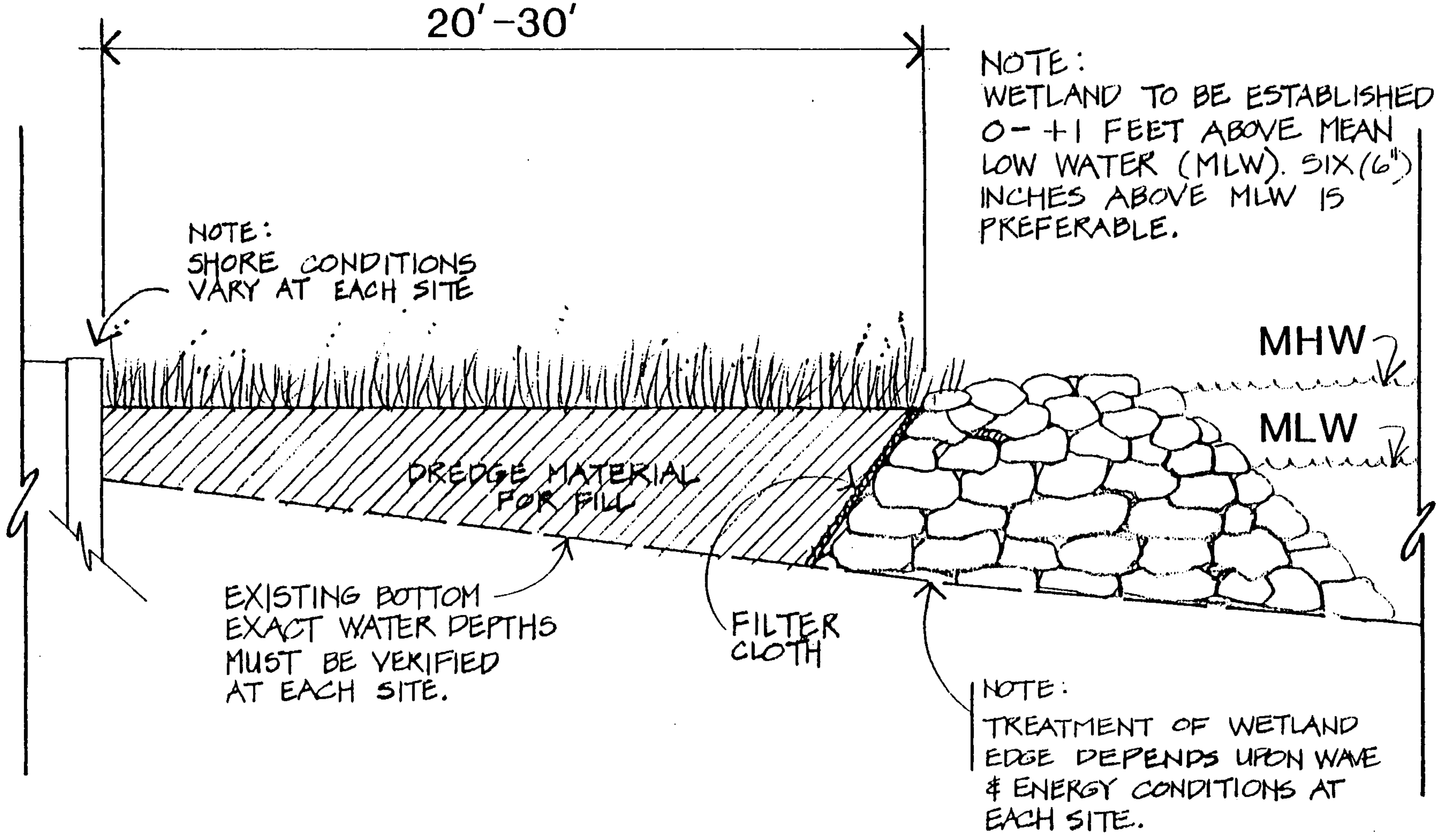

Figure 2-4.

TYPICAL FRINGE MARSH CROSS SECTION
Scale: 1/4"=1'-0"

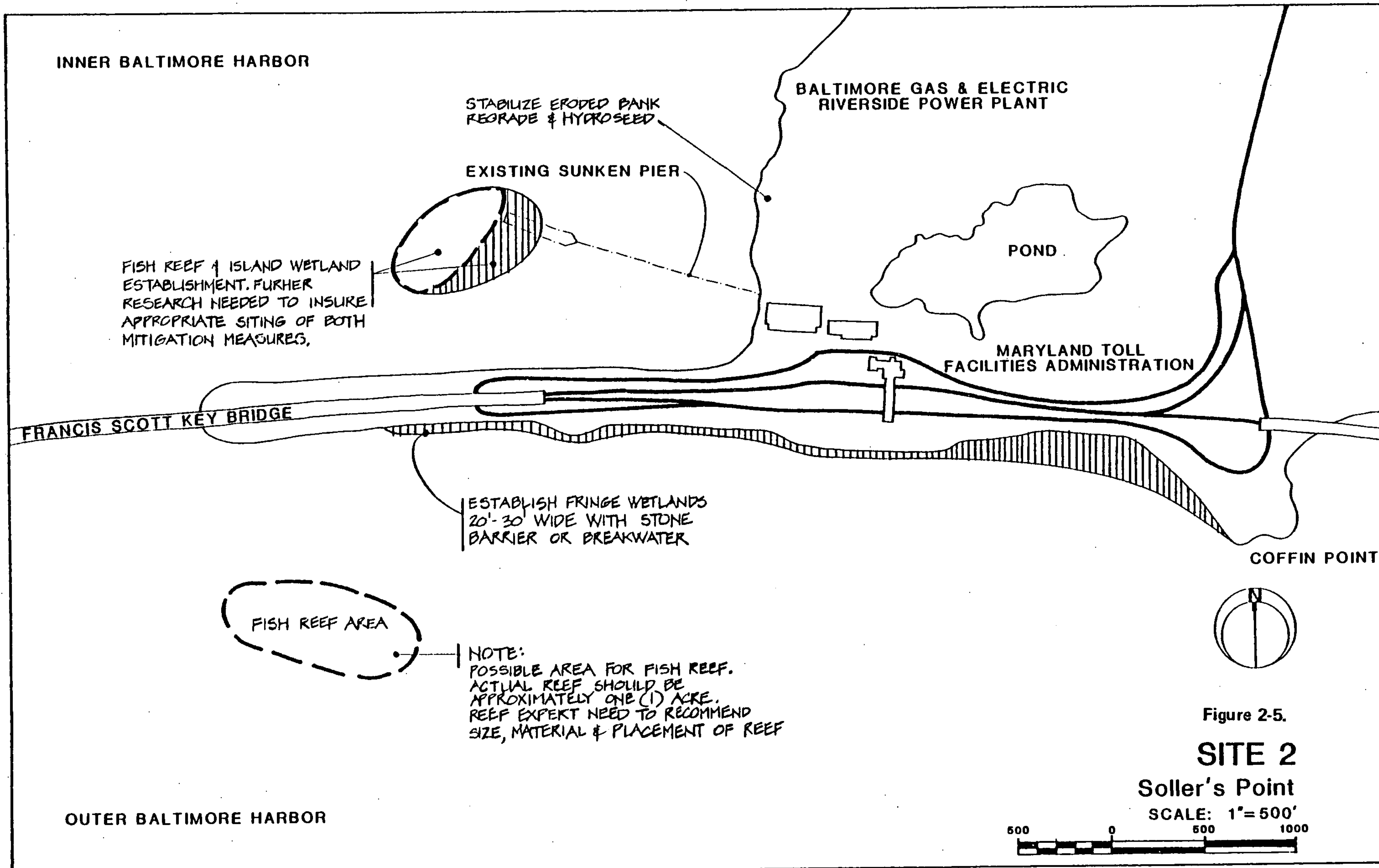

Figure 2-5.

SITE 2

Soller's Point

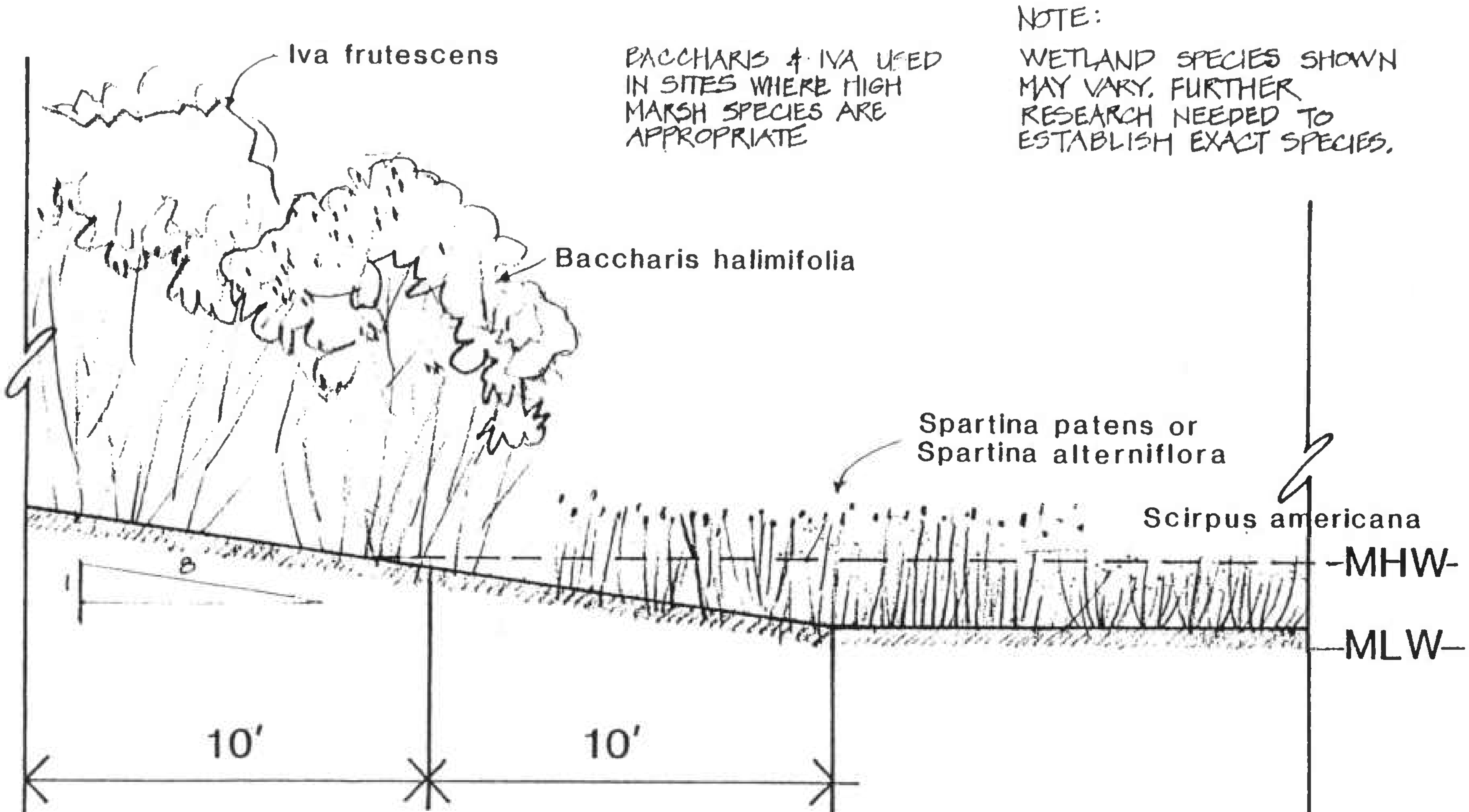

Figure 2-6.

TYPICAL SALT WATER WETLANDS CROSS SECTION
Scale: 1/4″=1′-0″

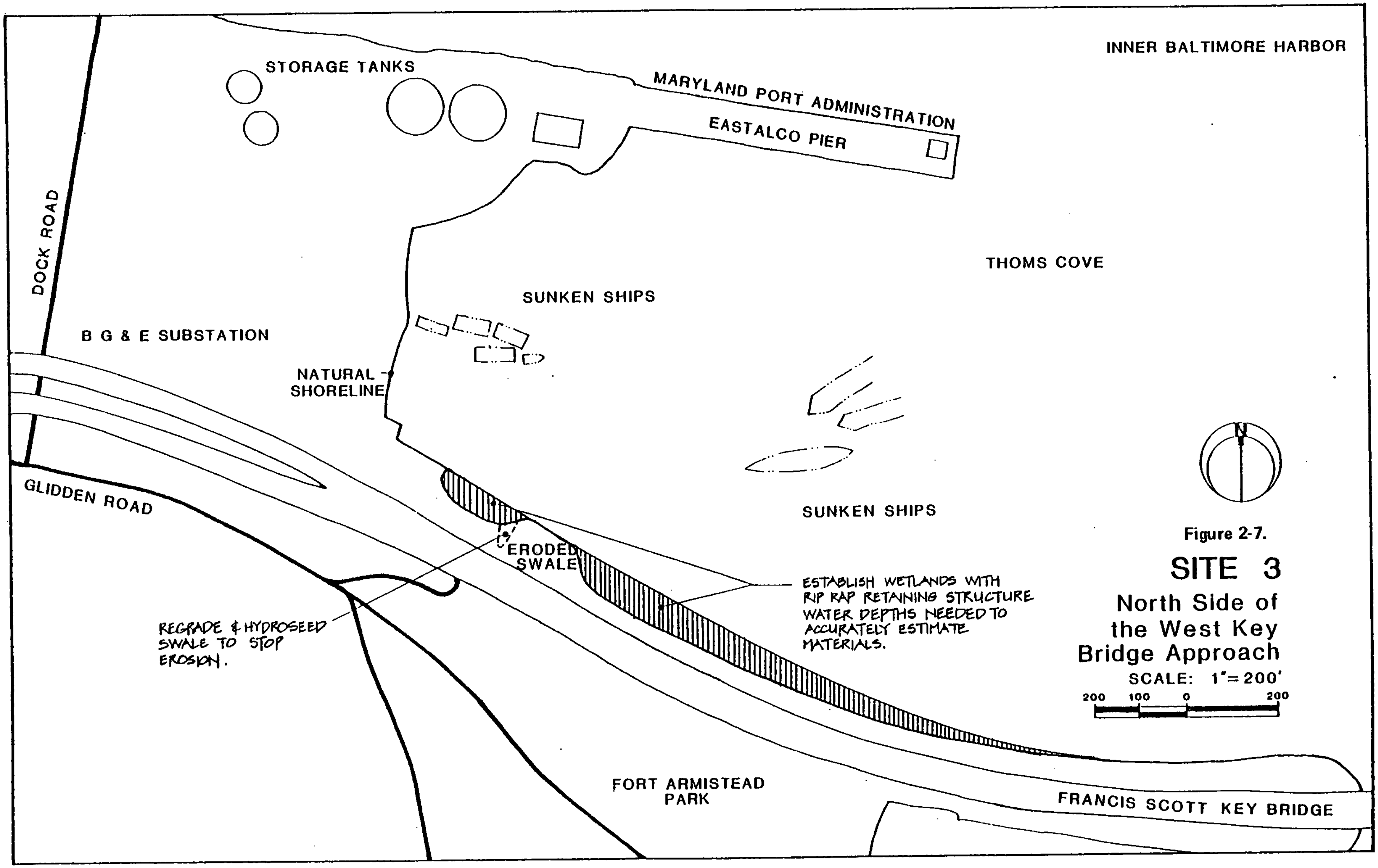

Figure 2-7.

SITE 3

North Side of the West Key Bridge Approach

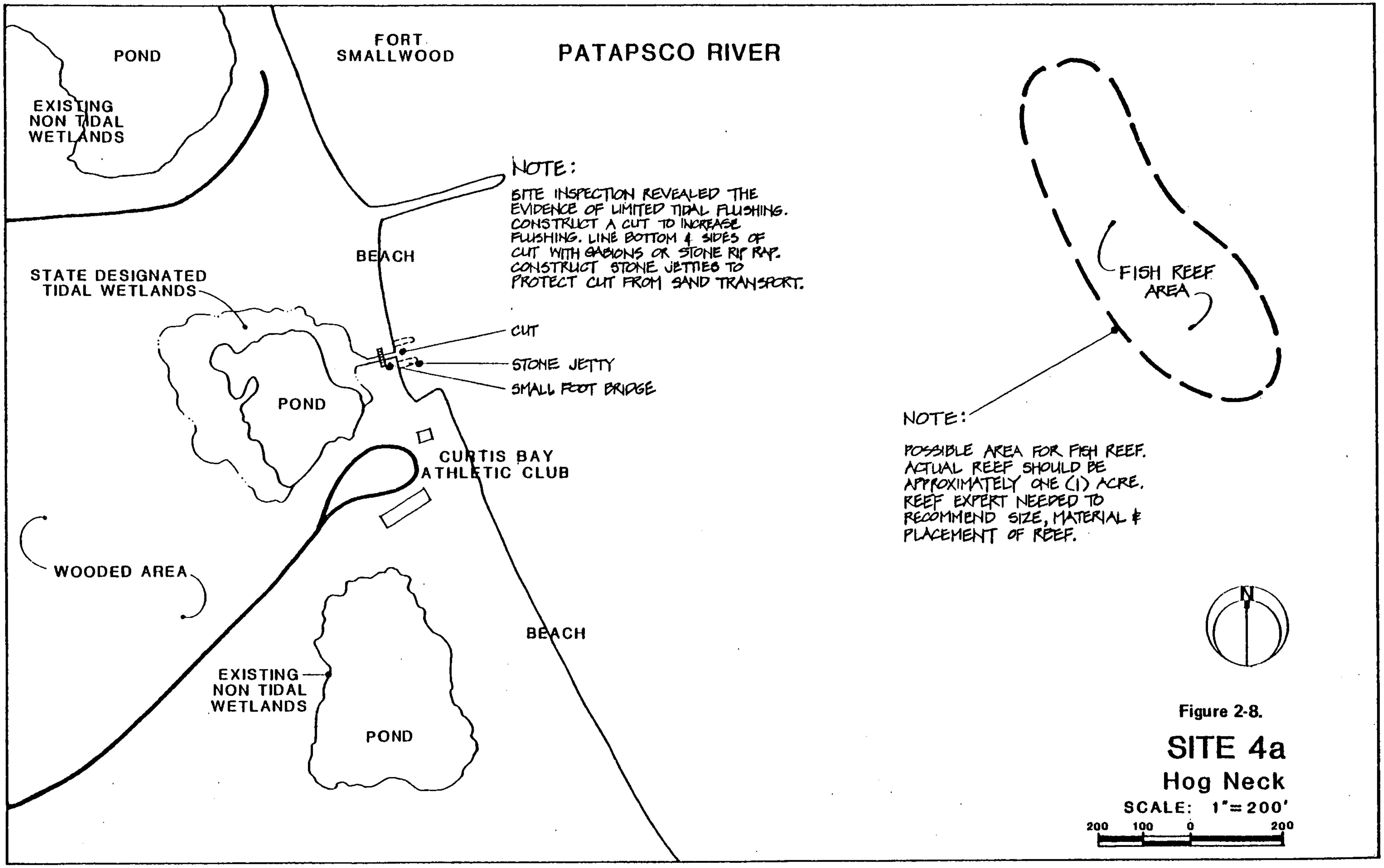

Figure 2-8.

SITE 4a

Hog Neck

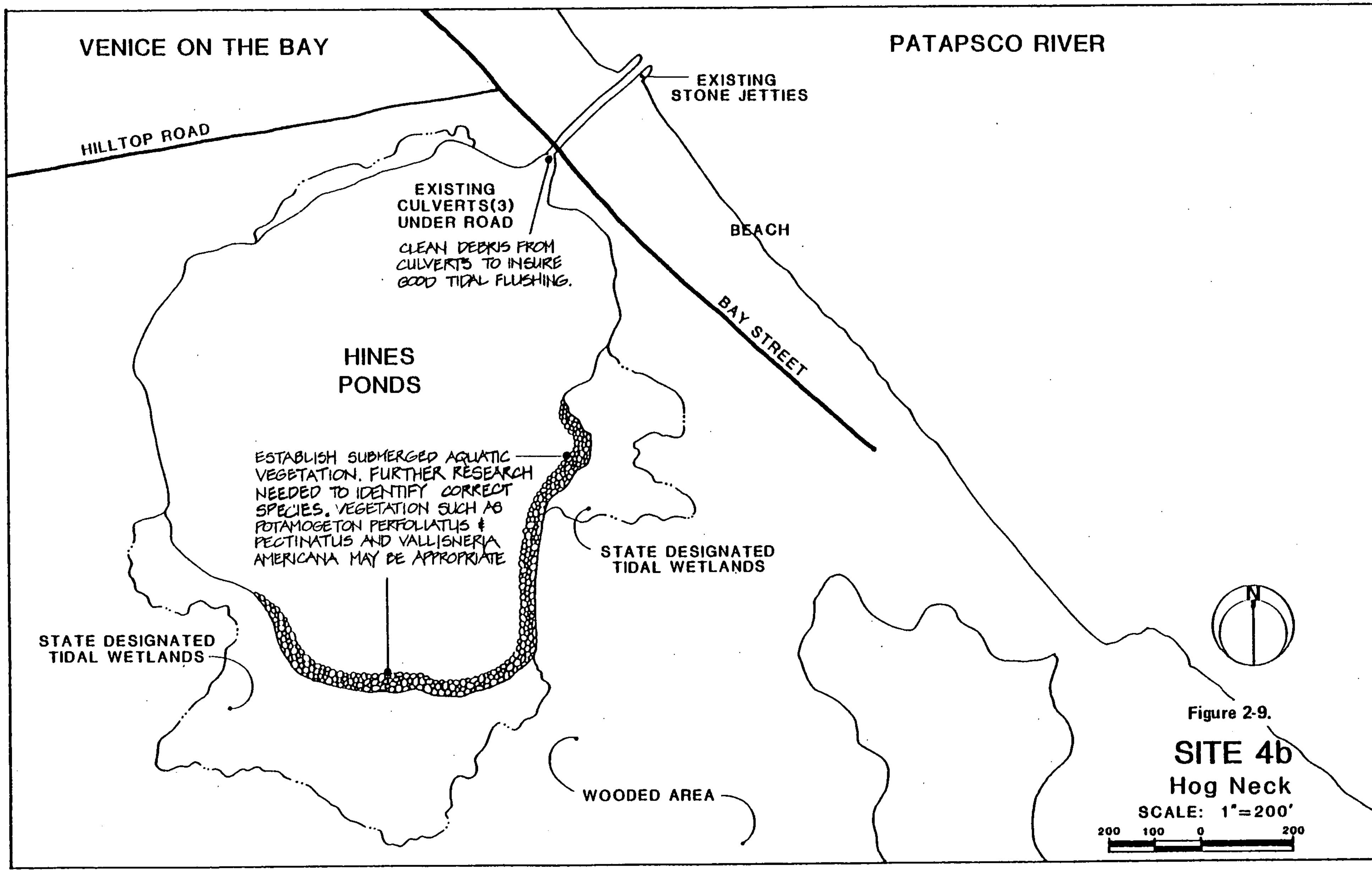

Figure 2-9.

SITE 4b

Hog Neck

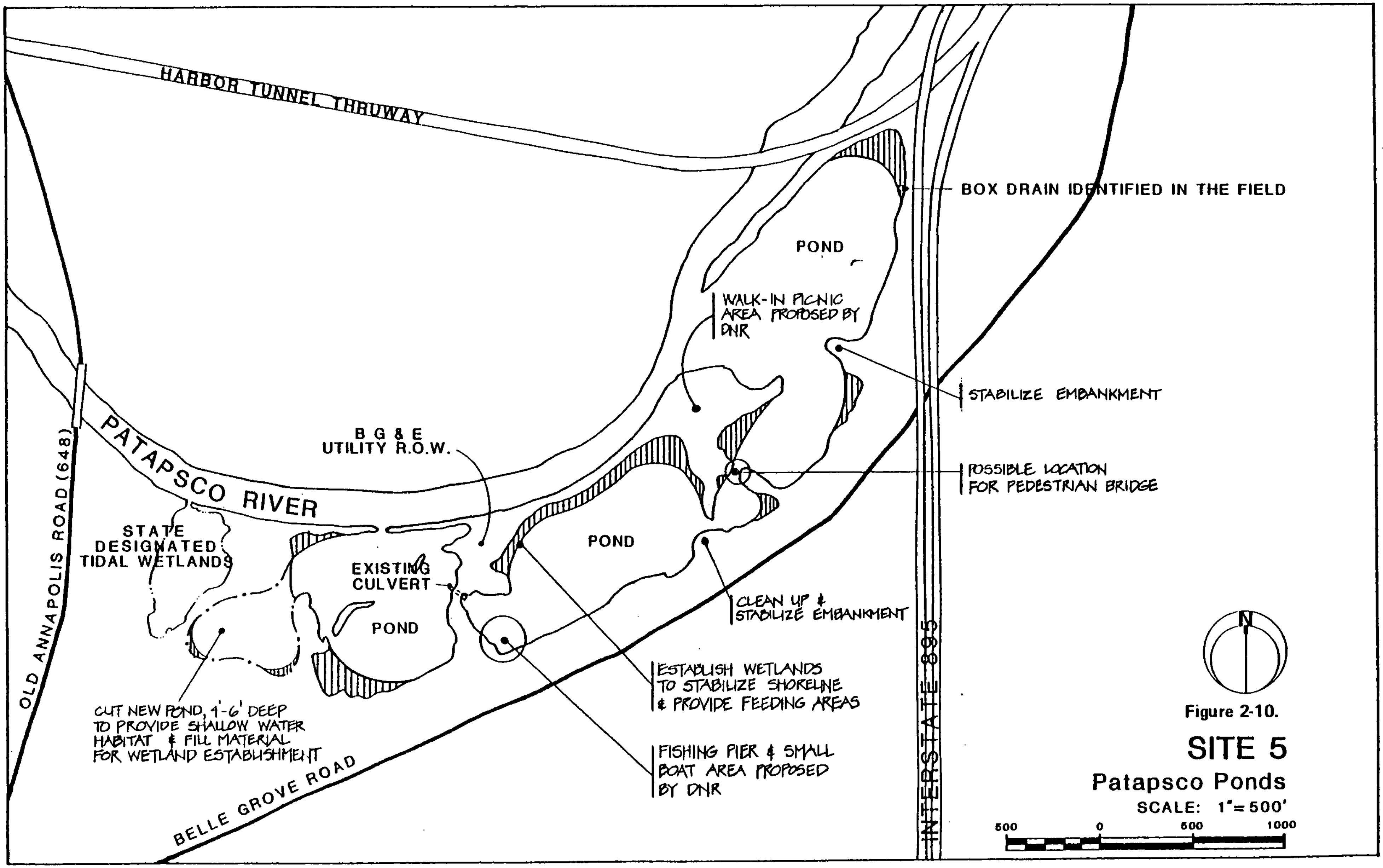

Figure 2-10.

SITE 5

Patapsco Ponds

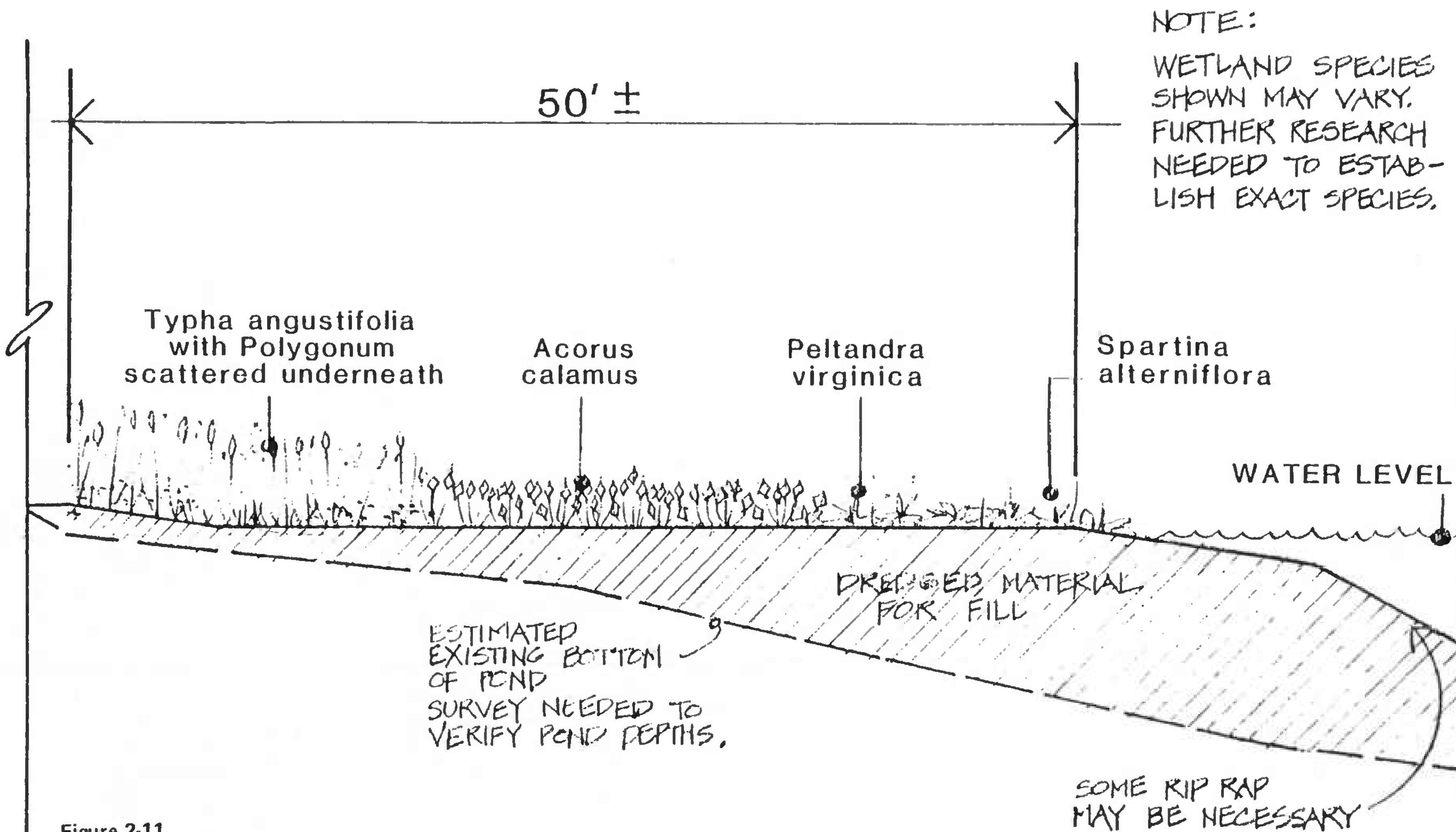

Figure 2-11.

TYPICAL FRESH WATER WETLANDS CROSS SECTION
Scale: 1/8"=1'-0"

3. IMPLEMENTATION PROGRAM

The means exist for improving the quality of the harbor while reducing delay to projects requiring mitigation. This plan has been developed to achieve those ends, both separately and together. The implementation program proposed here concentrates on reaching these two objectives simultaneously through the fill permit process. The federal regulations require permits for fill in the harbor from the U. S Army Corps of Engineers under Section 404 of the Clean Water Act (consistent with Section 404 B(1) Guidelines) and Section 10 of the 1899 River and Harbor Act. The State of Maryland, under the Wetlands Act, requires a wetlands license for fill in state wetlands and a wetlands permit for private wetlands. Tidal wetlands lying below the mean high water line are state wetlands; those lying above the mean high water line, subject to regular or periodic tidal action and supporting aquatic growth are private wetlands. A new handbook[1] prepared by the Coastal Resources Division of the Tidewater Administration, provides the appropriate guidelines and criteria used for federal and state agencies for analyzing dredging and fill projects.

Implementation of this plan will be accomplished in many ways. The focus of this program is on the fill permit process[2]. This implementation program outlines how that process can be facilitated to reduce delay for complex projects and offset resources lost in the harbor. Other ways to offset past losses include the use of aquatic habitat enhancement when parks or other types of shoreline access are constructed. Shoreline erosion control could include the construction of wetlands. The additional enhancement activities should be included in local and state plans and capital budgets.

The fill permit process and the ways it can be facilitated to implement the Baltimore Harbor Environmental Enhancement Plan are described below. The existing situation is described because some progress has already taken place toward a minimum level of improvement. The interim situation description which follows contains several administrative ways a higher level of improvement and cooperation can be achieved within one year. The ultimate situation described is the most effective way both objectives can be achieved without major changes to the regulations. The ultimate situation should be achieved within three years.

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1 Coastal Resources Division, Tidewater Administration. 1982 Maryland Dredge and Fill Permit Process Handbook.

2 Some dredging permits may eventually be included and will be studied separately during the implementation of this plan.

3.1 EXISTING SITUATION

Before receiving approval, each dredge or fill permit application to the Corps of Engineers and the Water Resources Administration for projects within the Baltimore Harbor (in excess of that necessary to control erosion and maintain access) should meet the following criteria:

1. The projects should be water-dependent (considering the scarcity of developable shoreline in the harbor). The only exceptions considered are existing non-water dependent uses which must demonstrate that there are no feasible alternatives for these activities.

2. The proposed project must meet a demonstrated public interest (i. e. net increase in employment, tax base, taxes, public access, etc.).

3. The proposed project must be the most practicable alternative considering both the environment and economic resources. (To be determined by public interest review.)

4. The proposed project must minimize, to the maximum extent possible, the amount of dredging and/or filling and the total adverse environmental impacts which can be expected.

In addition to meeting these criteria, information for many other considerations and components of the environmental impact determination must be provided by the applicant. When this information is assembled, the reviewing agencies determine (on a case-by-case basis) if the proposed project satisfies the criteria. In cases where the agencies' review finds projects which are questionable, a roundtable meeting is held with the applicant to determine what changes can be made in the project to meet the criteria listed above. Any exceptions, such as the existing uses mentioned in criteria number one above, must demonstrate a high degree of public interest or benefit. If this is not demonstrated, the permit will probably be denied.

Once the criteria are met, mitigation or compensation for the area to be filled is negotiated. The federal agencies require mitigation in the form of replacement or substitute resources (such as wetlands creation, wetlands restoration, fish reefs, etc.) as close to the project site as possible for any amount of fill. Ideally, mitigation is required on a one-to-one basis (in-kind); however, this is generally not possible and a compromise is worked out. State guidelines are somewhat different. If a project is approved by the Board of Public Works, it is their policy to assess monetary compensation, usually employing a guideline of one-third the fair market value of the land created. This money is usually deposited in the Wetlands Acquisition Fund, which is often used to consolidate wetlands holdings in the state wildlife management areas on the Bay's eastern shore. The average of all monetary compensation charged in the last seven years is $1,437 per acre of filled area. However, the average value of industrially zoned vacant land in the harbor is between $50,000 and $150,000 per acre.

Joint processing of state and federal permits (combining the staff review meetings for Corps of Engineers permits and State wetlands licenses) has increased the coordination on projects requiring both permits. In addition, an informal agreement has been reached between the two levels of review. If the federal agencies have worked out a satisfactory mitigation plan to replace the state's resource values on a particular project, the state will usually waive the requirement for monetary compensation in connection with the wetlands license on the same project.

The process of developing a satisfactory mitigation program can add a considerable amount of time to the permit process. The steps described in the interim and ultimate situation below would, if implemented, significantly reduce the average time to process permits requiring mitigation (currently 6-16 months when applicant response time is subtracted from total time.)

Once these permits have been approved, the Maryland Port Administration requires a separate permit for dredging, filling or structures in harbor waters. Their review, usually about two weeks long, checks on three criteria: first that the design is adequate and certified by a professional engineer; second, that the project does not infringe on adjacent property owners' riparian rights; and third, that the project does not present a hazard to navigation.

3.2 INTERIM SITUATION

An initial step to improve the process would be to formalize the agreement between state and federal agencies to consider recommended mitigation projects in lieu of monetary compensation. This would work most effectively if state agencies were more closely involved in developing mitigation projects.

Mitigation projects for Baltimore Harbor fill should include those proposed in the Baltimore Harbor Environmental Enhancement Plan. Five of the many sites indicated on the map of potential projects were developed into conceptual site plans to indicate the type of development possible. One of these five initial sites or any of those appearing on the map of potential sites could be used. This, however, does not preclude the use of other alternative measures which will enhance the harbor's aquatic habitat.

The basis for determining mitigation requirements should be clarified and tailored to conditions in the Baltimore Harbor. Because absolute resource values are difficult to determine, it may be useful to develop a cost schedule based on creation of substitute resources. A preliminary estimate was prepared for the five sites described earlier in this report which would serve as a starting point for these discussions. In any case, the amount agreed upon should not be less than the current guidelines (one-third fair market value). The amount could then be applied to any one of the enhancement projects or contributed to an appropriate fund to accomplish some improvement in the harbor's aquatic habitat. For the fund contributions to meet federal mitigation requirements, these improvements should be developed fairly close to the fill project.

Several different mechanisms are available for accumulating and applying these funds to mitigation projects. The Wetlands Acquisition Fund (the account which is currently used to receive compensation funds) could be modified to fund wetlands construction or other enhancement projects. The Fisheries Research and Development Fund has also been used to receive compensation funds intended for fisheries enhancement. New criteria could be added to either of these mechanisms or another type or combination of funds used to accumulate compensation receipts.

The steps described above to achieve the interim situation should be completed by September, 1983.

3.3 ULTIMATE SITUATION

The ultimate situation would provide a stable, reasonable system for assessing mitigation in Baltimore Harbor which would offset lost resources and increase the opportunities for enhancement. The existing method of assessing compensation or constructing mitigation projects does not achieve an equitable substitution of resources. A steady, predictable source of funds is desirable and continuing cooperation is essential.

Assessing an annual fee, or leasing state wetlands for fill, is one way to assure predictable funding for enhancement activities. Delaware, for instance, charges $1.50 per square foot for fill in open water. Charges this high could be difficult to assess in Maryland; however, if the permit process were shortened by as much as one year, savings to industry would be substantial.

Whether by lease or one-time fee, the ultimate situation would provide a simple means for setting a fee (a standard cost per acre for approved fill) charged to the applicant which could be accumulated and applied on a yearly basis to the completion of projects contained in the Environmental Enhancement Plan. The applicant should be given the option of paying the fee or constructing a mitigation project which satisfies the permitting agencies. Any funds collected could be accumulated either by state or by a non-profit concern which could design and construct mitigation projects as funds permit. Management of the completed mitigation project could be the responsibility of those who manage the fund, or they could be dedicated to a conservation organization or a public agency (especially where they abut parks or schools).

3.4 CONCLUSION

The new requirements for faster permit processing make this kind of approach essential to maintain what environmental gains we have achieved in the Baltimore Harbor. The success of this plan depends upon the permitting agencies reaching the necessary agreements. A forum for discussion and background work will be provided by the Regional Planning Council and the Environmental Enhancement Task Force. The continuing cooperation of all involved will assure that the following recommendations of the Baltimore Harbor Environmental Enhancement Plan are implemented.

1. The Maryland Board of Public Works should consider recommended mitigation projects in lieu of or in addition to monetary compensation for state wetlands, especially in Baltimore Harbor.

2. Mitigation projects for Baltimore Harbor should include projects from the Environmental Enhancement Plan.

3. Where monetary compensation is appropriate, federal and state environmental review agencies should recommend a fee system based on the cost of replacing the resource, giving a comparative analysis of the system with the cost determined by the present formula for computing compensation utilized by the Board of Public Works.

4. Priorities for the Wetlands Acquisition Fund, the Department of Natural Resources Fisheries Research and Development Fund, and/or other funds as appropriate, should include sites and projects from the Baltimore Harbor Environmental Enhancement Plan. Funds should be accumulated and applied to these sites and projects in a logical and timely manner to offset loss of resources due to approved fill projects.

5. The Maryland Board of Public Works should consider leasing as an option instead of a one-time fee for filling of open water.

6. If recommendations 3-5 are accomplished, the federal environmental review agencies should accept compensation to the state for use in recognized mitigation projects as fulfillment of federal mitigation requirements for approved fill in Baltimore Harbor.

If these recommendations are implemented, the time-consuming process of designing and getting approval for a mitgation project would be virtually eliminated for fill projects which meet the criteria established by federal and state agencies. Mitigation costs would be obtained from the developer, and the state would assure federal environmental agencies that the mitigation is properly designed, permitted, constructed and maintained, and adequately offsets resources lost due to fill projects.

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APPENDIX A:

SHORELINE INVENTORY

APPENDIX A: SHORELINE INVENTORY

Existing shoreline conditions were assessed using available literature (e.g., RPC 1981b; Ecological Analysts 1977; Koo 1975; MDNR 1977; U.S. DOT 1979); maps, including Maryland Department of Natural Resources wetland maps (MDNR Anne Arundel County Numbers 1, 2, 3, 5, 7, 8, 9, 10, 11, 22, 24, 25, 33, 34, 35, 40, 73, 74, 75 and Baltimore County Numbers 30, 37, 38, 44, 45, 57, 58, 62, 63, 64), United States Geological Survey quadrangle maps (Gibson Island, Sparrows Point, Relay, Baltimore West, Middle River, Curtis Bay, and Baltimore East); the RAMS Data Base (Bridgeland et al. 1981); and aerial photographs supplied by the Regional Planning Council. The Harbor shoreline has been subdivided according to Quirk, Lawler and Matusky's classifications (QLM 1973) to allow comparison of existing shoreline conditions to water quality, sediment quality, and biological quality on a section-by-section basis (Figure 1-1). The sections are the Northwest Branch; the Upper Middle Branch; the Lower Middle Branch; the Patapsco River; the Inner Harbor, including Colgate Creek and Curtis Bay and its tributaries; the Outer Harbor, including Bear Creek, Old Road Bay, Stoney Creek, and Rock Creek; and finally the Mouth of the Harbor, including Shallow Creek, Black Marsh, and Bodkin Creek. The information generated from the shoreline inventory has been graphically illustrated on a map produced by Land Design Research. Categories describing the shoreline include:

- Natural shoreline (undisturbed)
- Altered shoreline (e.g., riprap or construction sites)
- Bulkheading
- Mudflats
- Wetlands
- Submerged aquatic vegetation
- Sunken ships
- Beaches
- NPDES discharge locations (including EPA's 21 Industries of Greatest Environmental Concern, Segal et al. 1979)
- Stormwater discharge locations
- Areas excluded from mitigation

The shoreline inventory begins at the head of the Harbor and proceeds to the mouth of the Patapsco River. The discussion focuses on one section of the Harbor at a time. Margin numbers are keyed to the site locations in Figure A-1 and to the site evaluation matrix summary (Table 2-1).

Northwest Branch

Most of the Northwest Branch will not be considered for mitigation. Only the area from Fells Point to Clinton Street, principally the shoreline along Boston Street, is examined. In this area the shoreline is retained by bulkheading and the water is highly polluted (Koo 1975). There is 1
a large open space proposed for condominium development. Potential construction runoff from this site and the current urban runoff from the adjacent Highlandtown section of Baltimore adversely affect biological quality. Ship traffic is heavy.

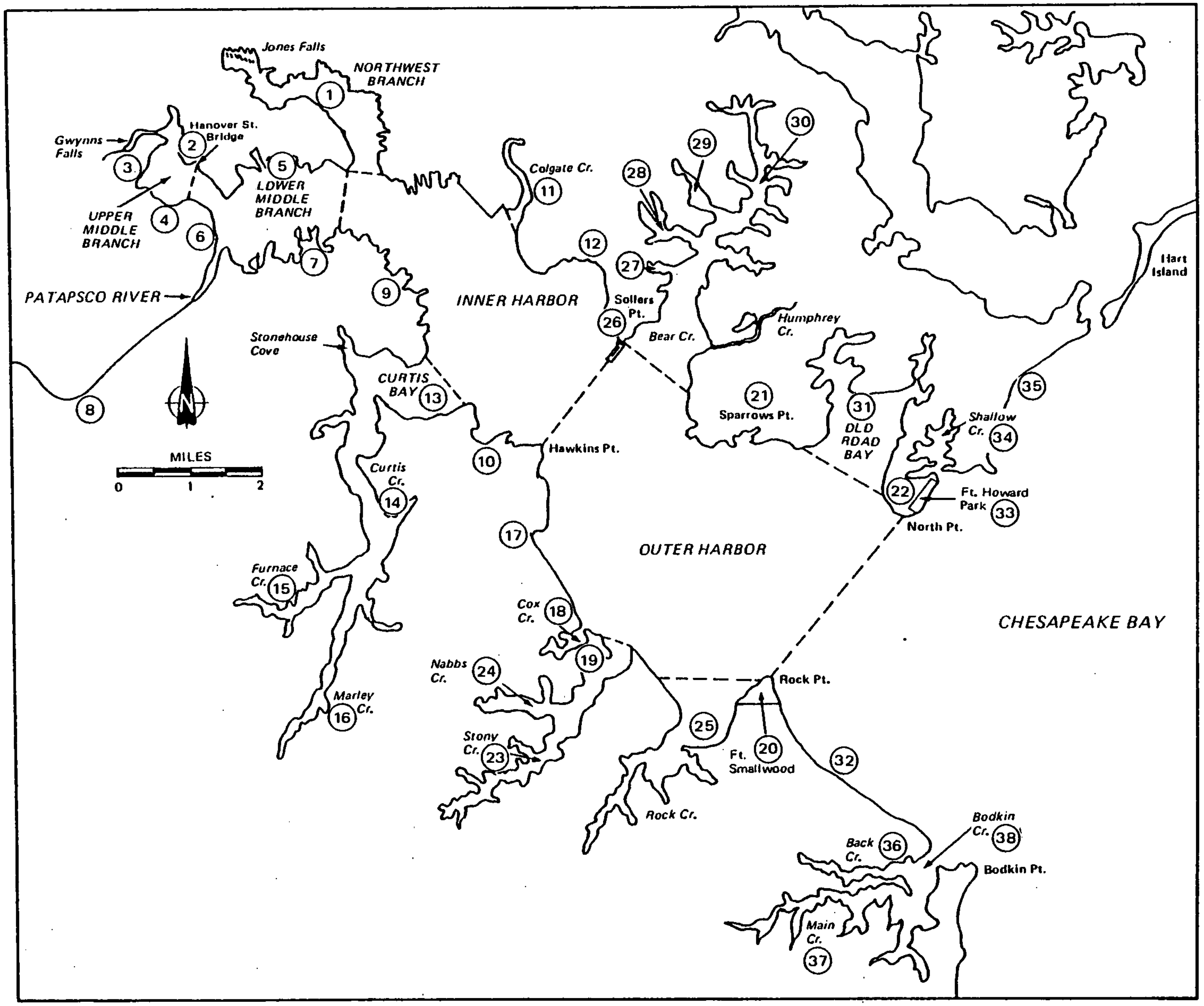

Figure A-1. Locations of the sites reviewed in developing the shoreline inventory. (See Appendix A and Table A-2.)

Upper Middle Branch

The area from the head of the Middle Branch extending to below I-95 is to be filled to create a wetland and therefore will be excluded from consideration for the mitigation study. The entire Middle Branch is currently highly polluted (MES 1974).

I-95 East to the Hanover Street Bridge

The eastern shore of the Upper Middle Branch includes a small park, Swann
Park, with athletic facilities for baseball, which is set back from the
shoreline creating a small cove north of the railroad tracks. The shore- 2
line west of Hanover Street has extended outward at one point creating a
sandbar. This area is not bulkheaded.

I-95 West to the Waterview Avenue Park

Most of the shoreline in this section is not bulkheaded except for a 3
small section on the southwest bank below the railroad tracks. This
shoreline is cluttered with trash and debris, as is a small beach south-
east of the tracks. Waterview Avenue Park is primarily open space but 4
its shoreline is edged with trees. Along this shoreline is a thin beach
and to the west a marina which might generate boat wake problems. Smith
Cove, located in the southwest corner of the Upper Middle Branch, 3
contains sunken ships and a large sediment plume which gives the cove the
appearance of a mud flat, particularly during low tides.

Lower Middle Branch

Hanover Street Bridge to Fort McHenry

The northern shoreline of the Lower Middle Branch extends from the
Hanover Street Bridge to Fort McHenry. Much of this area is not to be
considered due to ownership, routine dredging maintenance, and other
current commitments. In addition to the large shipping operations out 5
of Port Covington, there are two other busy, smaller boat marinas.
There is virtually only one area in the stretch of shoreline that is
under consideration--the Ferry Bar Park which is not bulkheaded. There
is also a small beach that is somewhat protected from northwest winds.

Hanover Street Bridge to the Harbor Tunnel

Fifty percent of the southern shoreline of the Lower Middle Branch is not
being considered for mitigation. This is primarily the result of past 6
filling at Reed Bird Island and proposed filling at Masonville. East of
Hanover Street Bridge at Broening Park and in front of South Baltimore
General Hospital, the shoreline is protected by riprap and bank armament.
At Broening Park the shoreline is dotted with a few trees but is other-
wise open. In front of the hospital, a beach runs the length of the 7
hospital property and is kept reasonably cleared of trash and debris.
From Masonville east to the Harbor Tunnel, the shoreline is entirely
bulkheaded.

Patapsco River

Patapsco Valley State Park Area

The section of Patapsco Valley State Park included in the study area is east of Route 1. Vegetation along the river is influenced by periodic flooding which has created a broad floodplain margin. Poorly defined meandering streams are common. The soil type is the Sassafras-Chillum-Aura Association, which consists of deep, well drained, nearly level to steep soils on uplands of the Coastal Plain (MDNR 1977).

The entrance to the park from the Harbor is bordered by Reed Bird Park. Southwest Area Park, west of Reedbird Park, is an undeveloped site, consisting primarily of mud flats, wetlands, and open areas. The site is wet with meandering streams and creeks that must be considered when proposing mitigation.

The park area from Route 1 to the Harbor Tunnel freeway is a wetland/ shrub marsh zone with some upland forest associations. There are more than 10 ponds in this area, the largest being the Halethorpe Farm and Belle Grove ponds (also referred to as Seven Ponds). These ponds, which support bullhead, sunfish, catfish, and pickerel, are currently used for recreational fishing (MDNR 1977). 8

In 1977 the Maryland Department of Natural Resources developed a master plan for future development in Patapsco Valley State Park. Because the land is too soft for high-density recreation, emphasis was placed on water-oriented recreation. Piers, observation walkways, fishing, and nonmotorized boating activities have been proposed for this area; a nature interpretive center and an amphitheater have been suggested. During winter, ice skating areas activities are planned. Coordination of the Harbor enhancement project with this master plan may prove beneficial. Access to this area is possible via Halethorpe Farm Road, Bank Street, Nursery Road, and Belle Grove Road.

Inner Harbor

The Inner Harbor area extends from the Harbor Tunnel to Hawkins Point on the south, and from the Harbor Tunnel to Sollers Point on the north. This area is highly industrialized, very polluted, and heavily utilized for ship traffic.

Harbor Tunnel to Hawkins Point

From the Harbor Tunnel to Fishing Point, the shoreline is almost 95 percent bulkhead. Two large shipping channels off the Fort McHenry Channel are located here, suggesting routine dredging. The Patapsco sewage disposal plant and the proposed B.G.&E. power facility at Wagners Point dominate the municipal facilities in the area. There is one cove area, south of the light locating the northernmost channel, that has a natural shoreline and is suitable for mitigation. It is a site of non-point pollution from the Curtis Bay area and this shoreline, along with any others selected in this area, should be managed to reduce the impact of such pollution. 9

The remaining southern stretch of the Inner Harbor, Leading Point to Hawkins Point, is a mixture of shoreline with bulkhead, tidal flats, submerged aquatic plants (Macomber and Fenwich 1978), and sunken ships. The land occupied by the Maryland Port Administration (MPA) is publicly owned and enclosed by bulkheads. There is one area of trees on the MPA's land that should help reduce runoff from their parking lot. South of Leading Point and the MPA is Thoms Cove, now separated into two coves by the Eastalco pier. The channel leading to this pier must be routinely dredged, placing some limitations to mitigation. Both coves show signs of erosion, and there possibly is polluted runoff from adjacent landfills. Northern Thoms Cove has a submerged aquatic bed of _Potomogeton perfoliatus_, _Potomogeton pectinatus_, and _Vallisneria americana_. _Vallisneria americana_ is a preferred food source for many species of waterfowl and its existence should be encouraged. The cove south of the rail dock is occupied by sunken ships and has undoubtedly received heavy siltation during construction of the Key Bridge. The small cove south of the Key Bridge and north of Hawkins Point is a prime site for mitigation being considered by the I-95 study. 10

Colgate Creek

Colgate Creek is located between Point Breeze and the Dundalk Marine Terminal. Much of the area is bulkheaded, which renders it suitable only for cleanup and fish reefs. This creek is also very polluted. 11

Harbor Tunnel to Sollers Point

The northern shoreline bordering the Inner Harbor is characterized by heavy shipyard/industrial activities; much of this shoreline is reinforced and protected by bulkheads. The area from the Harbor Tunnel south to 12th Street at the Dundalk Marine Terminal (DMT) is not considered for shoreline mitigation because of these shipyard/industrial activities. Approximately 30 percent of the shoreline surrounding DMT is open for mitigation and is publicly owned; however, the area is heavily polluted and enclosed by bulkheads. Sollers Point is a large area, somewhat residential but was primarily utilized for the Key Bridge construction. The shoreline is not bulkheaded except for one area occupied by a large pier, creating the appearance of a natural shoreline. The shoreline is eroding but contains some established vegetation. 12

Inland, a small pond, which also appears to be in flux, occupies the higher elevations. A small band of riprapped shoreline surrounds the Key Bridge. All shoreline in the Sollers Point/Turner Station area is edged with debris and in need of shoreline cleanup. Sedimentation and erosion control measures are recommended to eliminate upland erosion.

Curtis Bay and its Tributaries

Curtis Bay and its tributaries present an interesting scenario. From the mouth of Curtis Bay south to the Curtis Bay Depot, the water is highly polluted, routinely dredged, and heavily utilized by ships. However, the creeks feeding Curtis Bay are surrounded by natural tree-lined shores with wetlands ranging in size from small to relatively large.

Curtis Bay

Curtis Bay will be defined here as that area east of and including Stonehouse Cove as the northern shoreline and east of Sledds Point as the southern shoreline. The water in this bay is very polluted as a result of industrialization; it is primarily occupied by the Curtis Bay shipping channel which further reduces the possibility of mitigation sites. Around Fishing Point west to a pier off the Seawall Branch Rail System, the shoreline is bulkheaded. West of this pier, up to and around Stonehouse Cove, is natural but behind which are no trees, only open space 13
surrounding the railroad tracks. Severe soil erosion south of East Brooklyn has probably caused substantial sediment accumulation in the small pond located there. Stonehouse Cove is filled with sunken ships along its eastern shore; Sledds Point has a natural tree-lined shore. A stream-fed settling pond contributes a visible plume into Curtis Bay. In front of this pond within the plume is a sunken barge that seems to contribute to the plume problem. Two ponds have been created by a line of sunken ships. The ships are lined up in such a way to suggest they were placed there purposely; they may be exposed during low tides. Eastward is a natural shoreline, enclosing a small cove that again has a sunken ship dividing it (aerial photography by MDNR).

Curtis Creek

Curtis Creek encompasses the area above the mouths of Marley Creek and Furnace Branch and below Curtis Bay. A shipping channel bisects the 14
creek which runs to the Curtis Bay Army Depot (GSA) on the west and to the U.S. Coast Guard Yard on the east, the two primary industrial sites in this area. Curtis Bay has three large docks enclosed by bulkheads. Cabin Branch has a sediment plume from a stream at its mouth and some bulkheading south of the railroad tracks, but is dominated by a disturbed natural shoreline. A large wetland with *Typha* spp., *Polygonum* spp., *Hibiscus* spp., and *Leersia oxyzoides* as the dominant plant species surrounds Cabin Branch and the tip of this tributary (MDNR wetland maps). Ferry Point south to the army depot is characterized by altered shoreline spotted with areas of bulkhead and sunken ships. The army depot is bulkheaded on its eastern shore but to the west the once disturbed shoreline is now becoming vegetated with trees, shrubs, and fringe marshes. South of Sledds Point, the shoreline is characterized by bulkheading surrounding the four piers north of Route 695 and the Coast Guard Yard, shipwrecks in the cove above Route 695, and small areas of disturbed natural shoreline at Walnut Point. South of the Coast Guard Yard at the Bohemian Beach Cove and Solleys Cove, are wetlands surrounded by forested areas. The wetlands are represented by associations of *Spartina alterniflora*, *Iva frutescens*, *Baccharis halimifolia*, *Typha* spp., and *Phragmites australis*. In addition, aerial photographs reveal a small border of submerged aquatic vegetation at Solleys Cove. The remaining shoreline is natural with thin beach areas lined by shrubs and trees.

Furnace Creek and Coves

The northern shoreline of Furnace Creek is undisturbed and heavily wooded. There is a large wetland at Furnace Branch inhabited by *Acer rubrum*, *Fraxinus pennsylvaniam*, *Typha latifolia*, and *S. alterniflora*; fringe marshes line the smaller coves. There are few piers, primarily because of low urbanization. Back Creek is the only creek on the northern shore of Furnace Creek that is named; it is fed by three streams which receive runoff from Glen Burnie Mall, the Morris Hill Development, and Curtis Bay Industrial Park. Although this creek probably exhibits low environmental quality, the shoreline is not bulkheaded and trees line the western bank. 15

The southern shoreline of Furnace Creek is natural but comprises a heavily residential area (Margate and Point Pleasant communities) which increases accessibility. There are two unnamed tributaries that penetrate the Margate community; both are stream fed and have small wetlands at their heads. The plant species are similar to those at the head of Furnace Branch. There is a pumping station just north of Hammarlee Road.

Marley Creek and Coves

Marley Creek is a larger tributary to Curtis Creek. Although most of the shoreline is natural, one shoreline is primarily residential (northern bank) and one shoreline is primarily undisturbed (southern bank). The northern bank residential communities are the same as those on Furnace Creek--Margate and Point Pleasant. There are many private piers but otherwise the shoreline is natural and tree-lined. Six wetlands are located in Marley Creek's Cove. Two wetlands are located at the head of Marley Creek supporting *Acer rubrum*, *Hibiscus* spp., and *S. alterniflora*; a creek meanders through the largest. Proceeding toward the mouth of Marley Creek, there are two unnamed coves that have small wetlands of similar quality. The shoreline from these small coves to the mouth of Curtis Bay is all natural and tree-lined. One of the two remaining wetlands is in a very small cove fed by a small intermittent stream. Tanyard Cove, the largest cove in Marley Creek, has been described as a significant resource and RPC (1981b) suggests that efforts should be made to preserve this area. The cove is lined by trees, has a natural shoreline, and supports a wetland at its head. The wetland is predominately *Polygonum* spp.-*Acorus calamus*-*Typha latifolia* associations but there may be some submerged aquatics. No beach is visible from aerial photography. Tanyard Cove is near the site of a sewage line break which may have temporarily elevated fecal coliform levels and nutrient concentrations in the vicinity. Route 10 is being extended across the head of Marley Creek; a mitigation plan is being developed but has not been funded at this time. 16

Outer Harbor

The Outer Harbor northern shoreline will be defined as that area extending from Sollers Point to North Point; the southern shoreline will be defined as that area extending from Hawkins Point to Rock Point.

Hawkins Point, Brandon Shores, and Cox Creek Area

The area between the Key Bridge and Fort Armistead Park is not being considered because it will be studied under another contract. Fort Armistead Park is a small publicly owned park with an exposed point, 17
a small cove, and a few boating piers that do not appear to be heavily used. There are small areas of trees scattered throughout open space. It is accessible via Glidden Road. The northern point is subject to northwesterly winds.

South of Fort Armistead Park are settling ponds that have created a large sediment plume extending along the shoreline. To the north is a sunken ship. Two sewage pipelines extend out from the shore; they are partially submerged but extend into the Outer Harbor for some distance. A large area has been indicated as a spoil disposal site. There is obvious erosion and runoff from this site. A submerged aquatic plant bed, dominated by P. perfoliatus and V. americana was located in the cove southeast of the Swan Creek area in 1978. The Hawkins Point/Marley Neck Site is zoned for industry; further, this shoreline is in need of cleanup.

The existing vegetation surrounding the two ponds at Swann Creek is Typha spp., Hibiscus spp., P. australis, and Spartina spp.

The Goose Neck area is the site of the B.G.&E. Brandon Shores Power Plant. Just north of the plant, the beach is jagged and riprap seems to be used to maintain the existing shoreline. There is usually a large storage area for coal piles and a discharge pipe is located just to the north. The shoreline is cluttered with trash and decaying tree trunks. Directly in front of the power facility is a channel for barges delivering fuel; the area is enclosed with bulkheads.

Three beds of submerged aquatics are located in Cox Creek; dominated by P. perfoliatus and V. americana (Macomber and Fenwich 1978). Four small wetlands in the small protected coves in Cox Creek support similar species--P. australis, Typha spp., and S. alterniflora. South of Cox 18
Creek is Stoney Beach, the shoreline consists of natural tree-lined banks with a few piers; a large bed of submerged aquatics persists along the shore.

Riviera Beach and Fort Smallwood Park

Riviera Beach is a well-kept residential beach with a small section of a community-owned land south of a large pond (located in the center of the community). The beach is occupied by a few piers and protected by riprap and jetties in a few areas. There is evidence of some erosion. Three 19
beds of submerged aquatics are located along this stretch characterized by the Potamogeton/Vallisneria association (Macomber and Fenwich 1978). The pond just northwest of Lake Road is aestically pleasing, and surrounded by trees. There is a small wetland at one bank of the pond composed of A. rubrum and Rosa palustris.

Fort Smallwood Park is a publicly owned park at Rock Point. On the eastern side there is one wetland inhabited by Spartina cynosuroides, 20
S. alterniflora, and Typha spp., two long piers, and some open beach spaces for picnics and beaches. There is a large pond lined with freshwater fringe marshes. Fort Smallwood Road provides access to the park.

Sparrows Point and Fort Howard

The shore surrounding Sparrows Point is of poor environmental quality. The water is heavily utilized for shipping; three channels dissect the 21
water and bulkhead encases almost 50 percent of the shoreline. The bulkhead is concentrated on the western shore near two channels; on the eastern shore there is a cove with one channel for ship access. The remaining shoreline is altered and cluttered with debris. Erosion is a problem and the area is constantly changing as a result of the filling undertaken by Bethlehem Steel.

The section of Fort Howard that falls into the outer harbor area is a 22
large military medical center which may have restricted access. The shoreline is essentially natural and lined with beaches. There is one pier which projects into the harbor just east of North Point. Access to this area is by North Point Road (Rt. 20).

Stoney Creek and Coves

Stoney Creek is surrounded by natural young forests (primarily the northern shore) and medium density housing (primarily the southern shore). 23
Submerged aquatic beds are at Orchard Beach and at the shoreline across from there. There is no bulkheading in this creek but many privately owned piers and marinas are located at Greenland Beach, Brightwater Beach, and in Back Cove. Small beaches are scattered along both shores and wetlands are located in many of the coves. There are no publicly owned lands along this shoreline. Nabbs Creek is surrounded by forests 24
and has a Spartina alterniflora/Scirpus spp./Typha spp., wetland at its head and a P. australis wetland/sand bar site at its mouth. Many of the coves are shallow and except in Back Cove there are not many piers. Access is via Solley Road but the area is relatively undisturbed by man. Sloop Cove and Eli Cove at the tip of Stoney Creek contribute a total of four wetlands (Spartina spp./Iva frutescens/ Baccharis halimifolia associations). There are a few privately owned piers located along this natural shoreline and one nice beach at Silver Sands. West of Eli Cove is a dense residential area which helps provide automobile access to three small coves, two of which have small wetlands (Spartina spp./Typha latifolia/Pharagmites australis associations). Another S. alterniflora wetland is located at the head of Long Cove. Piers dot the shoreline but their density is low surrounding the wetland. A small beach area is located at Beauty Beach. Big Burley Cove is fed by four streams which provide a suitable habitat for lowland forests. The Mount Pleasant Beach community has an open shoreline and a wetland located in Beehive Cove. Sunset Beach, south of Route 173 and the point at Park Drive also have open beach areas. Between these two beaches is a cove which supports another wetland; a few private piers are present.

Rock Creek and Coves

Rock Creek is an area similar to Stoney Creek. The residential community located on the southern shoreline of Stoney Creek borders the northern shoreline of Rock Creek. Submerged aquatic beds are located at Surfside Beach, Water Oak Point, Woodland Beach, and Rock Creek Estates. There are seven marinas in this creek, suggesting heavy boat traffic. Much of the shoreline along Surfside and Rock Creek Estates is community-owned. 25

The northern shoreline of Rock Creek is residential and dotted with piers. Most of the shoreline was naturalized after housing construction. Only one (Spartina spp./Typha spp. Association) wetland is located on this bank; it lies at the tip of Long Cove surrounded by forests. There is a large, wide beach at Pine Grove Village. The tip of Rock Creek is characterized by a wetland (Spartina spp./Typha spp. Association) and a sewage pumping station.

The southern shoreline has three coves--Whites, Tar, and Wall--and a large pond with a tidal flat in front of it--White Pond. Whites Cove has no existing wetlands, Tar Cove has two, and Wall Cove has three. The dominant wetland species are Typha spp./Spartina spp. and Acer rubrum associations. Rock Creek Estates has a long beach with two ponds that are lined with lowland vegetation. White pond is the largest of these; it is tidally influenced and has a few piers for swimming and boating. The entire Rock Creek shoreline is natural although some areas have been altered during construction but have reestablished themselves.

Bear Creek

Bear Creek is a large multibranched creek located south of Dundalk. Its western shore is influenced by medium density housing but its eastern shore is bordered by the Sparrows Point Country Club at the north and Sparrows Point to the South. Bear Creek has been described as heavily polluted; there is not much flushing associated with this creek and settling ponds from Sparrows Point are located along its banks. Many small parks are situated along the coves penetrating Dundalk and most of these parks are close to schools. There is bulkheading below I-695 at Sparrows Point and the remaining shoreline is natural.

Sollers Point

Sollers Point supports the Francis Scott Key Highway. Erosion off this point is evident from aerial photographs, primarily caused by the lack of vegetation surrounding it. Fleming Park, a publicly owned area just north of Sollers Point, is in need of shoreline cleanup and erosion control. The park is undoubtedly subject to noise pollution because of its location adjacent to the Francis Scott Key Bridge Highway. There is a fenced area, in the water on the northern side of the park, near Lovel Point. 26

Peach Orchard and Clement Coves

Peach Orchard Cove has many small coves that are not occupied by wetlands or fringe marshes but seem to be prime sites for their development. One marina and a few small piers are located at the tip of this cove. Peach Orchard Park and Watersedge Beach Park surround the northern shoreline. (27) These parks primarily are occupied by open space with very few trees. Baseball diamonds and athletic fields dominate the park. The shoreline is altered because the park is frequently used.

Clements Cove is located above Fleming Park. At the mouth of this cove, at Cattail Point, there is a small wetland which is eroding away. The shoreline is disturbed due to human activities.

Bullneck Cove

Bullneck Cove's shoreline is characterized by three publicly owned parks; Chesterwood Park, Merritt Point Park, and Concrete Homes Park. Presently only one Spartina/Typha wetland exists in these parks; it is located in (28) the cove between Chesterwood Park and Merritt Park. The parks picnic facilities are utlized by the surrounding residents. Each park has a beach-type shoreline but they need cleaning-up and erosion control which will help stabilize the altered shore. The northern side of the mouth has a wooded, natural shoreline but is influenced by the Pennisula Freeway behind it. The southern shore is bordered by housing communities and is occupied by a few privately owned piers.

Lynch Cove

This cove has two parks on the shoreline--Lynch Cove Park and Inverness Park. Lynch Cove Park, the largest park on this cove, is mostly open (29) fields, has a pond covering approximately one-third of the land, and has a marsh in a small cove at the tip. The wetland seems to be in need of clean up; there is a large sand bar in the front of it which may have a tendency to collect trash. The northern shoreline is dotted with piers up to Inverness Park where there is an open shoreline which has minor erosion problem. The southern shoreline has many privately owned piers and there are two marinas at the eastern point.

Head of Bear Creek

The two dominant features at the head of Bear Creek are the abundance of residential homes bordering the shoreline and the Sparrows Point Country Club. There are wetlands at the tips of Chink Creek and Bear Creek and (30) another small wetland is located on the country club lands. Many school-grounds meet the shore, such as Sandy Plains, General Stricker, and Bear Creek. These shorelines also have a tendency to accumulate trash and could use some cleanup. In most areas except along the country club, the shoreline is unbulkheaded but has been altered. Numerous private piers are located along the shoreline. The shore adjacent to the country club is reverting to a natural area but is in need of erosion control. Up Schoolhouse Cove is a small park named Battle Grove Park which is publicly owned.

Old Road Bay

Old Road Bay is a large body of water relative to the other creeks and bays that border the harbor. There are no shipping channels or areas where large ships routinely dock except adjacent to Sparrows Point. 31 There are some bulkheaded areas around Sparrows Point but for the most part the shoreline is natural although altered by human activities. Many private piers exist along the shore especially in North Point Creek and Jones Creek. There is one marina, located at the mouth of Jones Creek. There are medium-density housing areas surrounding the tip of Jones Creek (Waterview), the middle of the Bay's shoreline (Chesapeake Terrace), and the tip of North Point Creek. There are 12 wetlands, most in North Point Creek. These wetlands are small and located in protected coves. Access to this area is good; however, there is no publicly owned land. The water quality is still poor even though this bay is near to the Chesapeake Bay.

Mouth of the Baltimore Harbor

The northern shoreline which borders the mouth of the Patapsco Estuary begins at Fort Howard Park, curves along Shallow Creek and proceeds northeast to Swan Point. The southern shoreline begins at Rock Point in Fort Smallwood Park and proceeds southeast to Bayside Beach. This is the cleanest section of the Harbor in terms of water and sediment quality.

Fort Smallwood Park to Bayside Beach

The shoreline from Rock Point to Bayside Beach is characterized by long 32 stretches of open beaches, seven wetland-lined ponds, and some stretches of community-owned shoreline. The shoreline of Fort Smallwood Park is publicly owned.

The section of Fort Smallwood Park included in this segment of the Harbor has long stretches of beach front and wooded areas that border open recreational space. A small cove located in the middle of the shoreline is adjacent to a large pond edged with a fringe marsh. This park is publicly owned and access is via Fort Smallwood Road.

South of Fort Smallwood Park is a long stretch of natural shoreline. The beaches extend to Bayside Beach, are relatively wide, and dotted with privately owned piers. The six remaining ponds, which range greatly in size, are two unnamed ponds located in Rockwood Beach, Hines Ponds (wetland dominated) which are located between Venice On The Bay, and Paradise Beach, Letha Pond southwest of a large marina, and Boyd Pond, the largest, with an inlet to the Patapsco River, located near Alpine Beach. All of these ponds are lined with fringe marshes and wetlands; the dominant species are *S. cynosuroides*, *S. alterniflora*, *P. australis*, *T. latifolia*, *Hibiscus* spp. and *A. rubrum* in transition zones between the wetlands and uplands. Access to this area is from Bayside Beach Road and Fort Smallwood Road. The high quality of the area, the public ownership and accessibility, make this shoreline a candidate for mitigation.

Fort Howard Park and Shallow Creek

Fort Howard Park is a publicly owned park facing the Chesapeake Bay. The land nearest the water is very wet, and although the Maryland Department (33) of Natural Resources does not map these areas of park in a wetland category, it is probably a shrub swamp. *Acer rubrum*, *Rosa palustris*, *Alnus serrulata* and *Salix nigra* are four plant species likely to occur here. Small areas of beach are located along this shoreline.

Shallow Creek is a small convoluted creek with wetlands along each of its coves. As the name implies the water is shallow, and these wetlands are dominated by *S. alterniflora*, *I. frutescens*, *B. halimifolia*, *P. australis*, *Scirpus* spp., and *Hibiscus* spp. Shallow Creek has a (34) natural shoreline, no piers, and is surrounded by forest and agricultural areas. These features, along with its proximity to the Chesapeake Bay and to a large wetland (Black Marsh), help this creek maintain a high biological quality. Access to this creek is only to its western shore via North Point Road.

Black Marsh

Black Marsh is the largest wetland in the Baltimore Harbor region; it is privately owned. The shoreline is natural except for a small pier (35) (which appears to be infrequently used) and a manmade jetty. A sunken barge rests off the tip of the pier. A large mudflat/pond area is located internally. There are long stretches of wide beaches boarded by fringe marshes and larger wetlands which act as a barrier from the water. Most of the shoreline is free of debris, but there are small areas that need to be cleared. Biological quality is high in this area which is frequented by many species of birds, primarily waterfowl. A sediment plume originates from the eastern stream bisecting the wetland. Access to this marsh is via Miller Island Road. The community of Swan Point borders Black marsh to the east, and uses the clean open beach south of Chesapeake Avenue.

Bodkin Creek and Coves

The aquatic environment in the Bodkin Creek area is composed of three (36) creeks--Back Creek, Main Creek, and Bodkin Creek proper. Back Creek's shoreline is primarily natural but there are residential areas and two marinas which may have altered this quality; five brackish wetlands are located in the coves of this creek. Main Creek and Bodkin Creek are of similar quality to Back Creek; both have wetlands (a total of 14) in (37) protected coves, private piers and marinas, residential areas, and shorelines that are primarily natural. No significant bulkheading exists in this area. The shoreline around Bodkin Neck is essentially unaltered by (38) man, that is, there are no houses and few roadways; brackish wetlands border the shore and waterfowl frequent the area. Most of the Bodkin Creek area is privately owned with the exception of Downs Park located next to Locust Cove off Bodkin Creek. Water quality and sediment quality are high in this area due to low urbanization (relative to the head of the Harbor) and proximity to the Chesapeake Bay. Water depth is relatively shallow; however, Main Creek has depths greater than 10 feet in its channel. Access to the shore is possible from Bayside Beach Road and Mountain Road; access to Bodkin Neck is minimal. No submerged aquatics or tidal flats have been reported in this system.

SITE EVALUATION MATRIX

The summary of the site evaluation matrix was developed by comparing enhancement activities to existing environmental conditions within discrete units of shoreline. The results of this are presented in the Site Evaluation Matrix (Table A-1).

Abbreviations of ranking criteria were necessary to construct the table; numerical values were assigned to each ranking criteria for evaluation purposes. Numerical values and abbreviations are as follows:

WD = water depth	1,2
WQ = water quality	1,2,3
SQ = sediment quality	1,2,3
WE = wind exposure	1,2
SW = ship wake	1,2
O = ownership	1,2
A = access	1,2
IP = improvement potential	1,2,3
NA = not applicable	

Water quality and sediment quality rankings were based on the data in the literature and interpreted in terms of effect on aquatic biota. The available data would not allow a specific determination at each site. Hence, the water quality criterion was incorporated the standard water chemistry measurements in an approximate fashion. Water quality received a 1 (poor), 2 (fair), or 3 (good) ranking value. The sediment quality ranking value was also a general determination. This criterion also received a 1, 2, or 3 ranking value.

Water depth, wind exposure, and ship wake frequency were physical characteristics determined from U.S. Coast and Geodetic Survey bathymetric maps of the Harbor and knowledge of ship and boat traffic patterns. These three parameters were assigned 1 (poor) or 2 (good) ranking values based on the specific requirements of each enhancement activity. For example, a shallow water area would receive a 1 value for a fish reef (which requires deep water) but a 2 for wetland construction (which is less complex in shallow water). Sites exposed to a long northwestern fetch are subjected to intense wave activity during the winter and therefore would be less suitable for marsh construction and would receive a 1. Protected areas would receive a 2. Intense shipping activity and associated wakes and wave action would have a similar effect on the nearshore environment. Heavy traffic areas would receive a 1; light traffic areas a 2. However, a certain condition may have a negative effect on one enhancement project but not on another. For example, a fish reef in sufficiently deep water may not be affected by wave action. Furthermore, a reef could protect the shore and reduce shore erosion.

The improvement potential criterion was based on a general assessment of the ecological condition of a site. This evaluation also incorporates a subjective determination of the potential for the success of a project at a site and attempts to balance project feasibility with resource scarcity. Healthy and productive shorezone areas with good biological diversity (i.e., species diversity, wetlands, SAV beds) would receive a 1. Areas low in biological diversity but with good water and sediment quality would receive a 3. Intermediate areas would receive a 2. Very poor, degraded areas where enhancement activities appeared to have little chance of success also would receive a 1.

Public access was a determination of the ease with which the public could obtain overland access to the site of an enhancement project. Access for project construction also was considered, although some enhancement activities may not require overland access. This determination was based on review of street and road maps and is an approximation of exact conditions. Access would receive a 1 or 2.

Ownership would receive a 1 for private ownership and a 2 for public ownership. This determination was made on the basis of potential problems associated with acquisition of shoreline for certain enhancement projects or for the construction phase of projects.

Where part of the area could be assigned a low rating while another secation of the same area would be assigned a higher one, a range resulted. The rank of a given site was always based on its higher value.

Matrix Production

A matrix was used to produce a numerical value for the ranking of each specific site or portion of the Harbor shoreline under consideration for enhancement or mitigation activities (see Table 2-1 for a summary of the matrix and Appendix Table A-1 for the entire matrix). The following process was applied to each site or general area. Each of the eight ranking criteria were applied separately to each of the six enhancement activities and appropriate values determined. The eight values generated under each enhancement activity were summed. This site-specific total, under each enhancement activity, then was divided by the maximum possible value, according to the ranking criteria, for that particular activity to yield a ranking value. This was done to equally weight the different enhancement activities. Using these numbers, sites could be compared within each enhancement activity. In order to rank sites in terms of their potential for all six enhancement activities, these six values were summed. Thus, the matrix yields values that allow site comparison on the basis of single enhancement activities and on the basis of all the activities.

Some ranking criteria did not apply to certain enhancement activities. In such cases an NA (nonapplicable) was inserted in the appropriate column. If a particular enhancement activity was totally inappropriate at a site, then numbers would be generated and the column would be left blank. This situation occurred only under wetland rehabilitation. Sites lacking wetlands could not be rehabilitated.

The Comments column on the right hand side of the matrix contains additional information on particular sites and includes some further recommendations for or against certain enhancement activities.

Table A-2 is a key to all the NPDES permits, which are located on the large map (Map 1 - Existing Conditions) available on request from the Regional Planning Council.

TABLE A-1 SITE EVALUATION MATRIX

(b)	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
1	Fells Pt. to Clinton St.	WD	1		NA	NA	1	2		Very poor water quality, all bulkheaded, deep water, and heavy ship traffic. Erosion control not applicable (NA) because of bulkheading; filling would be required for wetland construction.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	2	2	2		
		SW	1		NA	1	1	1		
		O	1		1	1	NA	NA		
		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total (x 100)		12/19=63		6/7=86	9/11=81	11/17=65	10/15=67	362	
2	I-95 E. to Hanover Bridge	WD	2		NA	NA	2	2		Next to Hanover Street Bridge is public (Swann Point). A small cove may be practical for wetland or SAV. No bulkheading, small sandbar, and depth varies from 2 to 10 feet. May be feasible for wetland construction and fish reefs.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	2	2	2		
		SW	2		NA	2	2	2		
		O	2		2	2	NA	NA		
		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		15/19=79		7/7=100	11/11=100	13/17=76	11/15=73	428	
3	I-95 W. to (but not including) Waterview Ave. Park	WD	2		NA	NA	2	2		Sufficient depth for fish reef. Smith Cove is a good site for wetland construction or SAV establishment except for boat wakes from marina. Bulkheading is limited and shoreline is in need of cleanup.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	2	2	2		
		SW	1		NA	2	1	2		
		O	1		1	1	NA	NA		
		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		13/19=68		6/7=86	10/11=91	12/17=71	11/15=73	389	

Note: Ranking Criteria abbreviations

WD	water depth	1,2
WQ	water quality	1,2,3
SQ	sediment quality	1,2,3
WE	wind exposure	1,2
SW	ship wake	1,2
O	ownership	1,2
A	access	1,2
IP	improvement potential	1,2,3
NA	not applicable	

(a) Totals are x 100.

(b) See Figure A-1 for locations by respective numbe

TABLE A-1. (CONT.)

	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
	Waterview Ave. Park	WD	2		NA	NA	2	2		Publicly owned, probably some management. Exposed to NW winds. Erosion control potential. Water depth adequate for wetland construction, SAV establishment, and fish reefs.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	1		NA	2	1	1		
		SW	1		NA	2	1	1		
4		O	2		2	2	NA	NA		
		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		13/19=68		7/7=100	11/11=100	11/17=65	9/15=60	393	
	Ferry Bar	WD	2		NA	NA	2	1		Water depth questionable for fish reef. Very close to Ferry Bar channel and ship wakes may be problem.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	1		NA	2	1	1		
5		O	1		1	1	NA	NA		
		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		13/19=68		6/7=86	9/11=82	12/17=71	9/15=60	367	
	Broening Park & South General Baltimore Hospital	WD	2		NA	NA	2	2		Water depth variable. Site probably best suited for wetland establishment or SAV establishment. Ship wake may be a problem.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	2		NA	1	2	1		
		O	1		2	2	NA	NA		
6		A	1		2	2	2	NA		
		IP	2		2	2	3	3		
	Total		12/19=63		6/7=86	8/11=73	13/17=76	10/15=67	365	
	South of Reed Bird Island to Harbor Tunnel	WD	2		NA	NA	2	1		Much of this area is being filled. Shoreline bulkhead and many drydocks, however, there are a few small coves that may be suitable for mitigation techniques. Water deep near piers but shallow elsewhere. Generally not a good area.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	1		NA	2	1	1		
		SW	2		NA	1	2	1		
7		O	1		1	1	NA	NA		
		A	1		1	1	1	NA		
		IP	3		3	3	3	2		
	Total		12/19=63		5/7=71	8/11=73	11/17=65	7/15=47	319	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
			Enhancement Activities							
	Patapsco St. Park	WD	2	2	NA	NA	2	2		Water depth variable; fish reefs would probably be most effective in the ponds. In general, the quality of the area is good, but room for improvement. (Proposed for Public ownership)
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	2	2	2		
		SW	2	2	NA	2	2	2		
		O	2	NA	2	2	NA	NA		
8		A	2	2	2	2	2	NA		
		IP	2	2	2	2	2	3		
	Total		18/19=95	16/17=94	6/7=86	10/11=91	16/17=94	15/15=100	560	
	Harbor Tunnel to Fishing Pt.	WD	2		NA	NA	2	2		Public ownership around Wagner's Point. Best area for wetland construction and SAV establishment is near fishing point (based on depths). Several deeper areas may be suitable for fish reefs. Water quality poor.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	1		NA	2	1	2		
		O	1		1	2	NA	NA		
9		A	2		2	2	2	NA		
		IP	3		3	2	3	3		
	Total		13/19=68		6/7=86	8/11=73	12/17=71	11/15=73	371	
	Leading Point to Hawkins Point	WD	2		NA	NA	2	2		MPA land is public. Lots of erosion in Thoms Cove. Shipwrecks are present and may presently be functioning as reefs. Coves are somewhat protected from NW winds. Depth suitable for plants and fish reefs. Ownership varies. Currently there are some SAV beds.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	2		NA	1	2	2		
		O	2		1	1	NA	NA		
10		A	2		2	2	2	NA		
		IP	3		3	3	2	3		
	Total		15/19=79		6/7=86	8/11=73	12/17=71	11/15=73	382	
	Colgate Creek	WD	2		NA	NA	2	1		Much of area is bulkheaded so little shore to cleanup. Very poor water quality. Fish reefs are questionable because of water depth. Rip rap and bulkheading are scattered along the shoreline. High clean up potential.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	2		NA	2	2	2		
		O	1		1	1	NA	NA		
11		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		14/19=74		6/7=86	9/11=82	13/17=76	10/15=67	385	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
	Dundalk Marine Terminal to Sollers Point	WD	2		NA	NA	2	2		Wind exposure can be bad in certain areas. Lots of erosion along shore. Water depths are good for plants and fish away from shipping channels.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	2	2	2		
		SW	2		NA	1	2	2		
		O	1		1	1	NA	NA		
12		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		14/19=74		6/7=86	9/11=82	13/17=76	11/15=73	391	
	Curtis Bay and Stonehouse Cove	WD	2		NA	NA	2	2		Wind exposure varies; on the southern side there may be a problem with NW winds. Very polluted with lots of ship traffic. There are enough depth variations to make habitats for fish and plants. Lots of discharges.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	2	2	2		
		SW	1		NA	2	1	1		
		O	1		1	1	NA	NA		
13		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		13/19=68		6/7=86	10/11=91	12/17=71	10/15=67	383	
	Curtis Creek	WD	2	2	NA	NA	2	2		Existing wetlands increase the matrix number--ship wakes are a problem. Areas for fish reefs, however, would be only in shipping channels. Water quality and sediment quality are 01
		WQ	1	1	NA	NA	1	1		
		SQ	1	1	NA	NA	1	1		
		WE	2	2	NA	1	2	2		
		SW	1	2	NA	2	1	1		
14		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	3	2	3	3	3	3		
	Total		13/19=68	12/17=71	6/7=86	9/11=82	12/17=71	10/15=67	445	
	Furnace Creek	WD	2	2	NA	NA	2	1		One area is public (near Hammarlee). Limited by depth for fish reefs. Area is reasonably nice already. Again the presence of wetlands increases the matrix number. Back Creek is subject to industrial runoff.
		WQ	2	2	NA	NA	2	2		
		SQ	2	2	NA	NA	2	2		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	1-2	NA	1-2	1-2	NA	NA		
15		A	2	2	2	2	2	NA		
		IP	2	2	2	2	2	2		
	Total		15/19=79 16/19=84	14/17=82	5/7=71 6/7=86	7/11=64 8/11=73	14/17=82	11/15=73	451- 480	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
16	Marley Creek	WD	2	2	NA	NA	2	1		Wind exposure may be a problem in some areas. Tanyard Cove has been reported to be of high environmental quality--water depth may limit the building of fish reefs. There is a mitigation plan (not funded) for the head of Marley Creek (extension of Rt. 10). A sewage line break has been recently repaired in Marley Creek.
		WQ	2	2	NA	NA	2	2		
		SQ	2	2	NA	NA	2	2		
		WE	2	2	NA	2	2	2		
		SW	2	2	NA	2	2	2		
		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	2	2	2	2	2	2		
	Total		15/19=79	14/17=82	5/7=71	9/11=82	14/17=82	11/15=73	469	
17	Brandon Shores	WD	2		NA	NA	2	2		Water quality is questionable in the area due to the settling ponds. There is enough variation in water depth for plants and fish. It also is away from the shipping channel. Access is not good. Large spoil disposal site and Brandon Shores power plant are here.
		WQ	2		NA	NA	2	2		
		SQ	2		NA	NA	2	2		
		WE	2		NA	2	2	2		
		SW	2		NA	1	2	2		
		O	1		1	1	NA	NA		
		A	1		1	1	1	NA		
		IP	3		3	3	2	3		
	Total		15/19=79		5/7=71	8/11=73	13/17=76	13/15=87	386	
18	Cox Creek	WD	2	2	NA	NA	2	1		Shallow water depth may limit fish reefs. Sewage disposal plant is here. Many beds of SAV. Area seems fair--upland might need some improvement. Existing wetlands raise matrix number.
		WQ	2	2	NA	NA	2	2		
		SQ	2	2	NA	NA	2	2		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	2	2	2	2	1	3		
	Total		15/19=79	14/17=82	5/7=71	7/11=64	13/17=76	12/15=80	452	
19	Stony Beach & Riviera Beach	WD	2		NA	NA	2	2		NW wind exposure is not a factor but area is not protected and wetland construction or SAV establishment may be costly or ineffective, respectively. One small area in Riviera Beach is community owned. One small inland wetland around pond. Large beds of SAV are present.
		WQ	2		NA	NA	2	2		
		SQ	2		NA	NA	2	2		
		WE	2		NA	1	2	2		
		SW	2		NA	1	2	2		
		O	1-2		1-2	1-2	NA	NA		
		A	2		2	2	2	NA		
		IP	2		2	2	1	2		
	Total		15/19=79 16/19=84		5/7=71 6/7=86	7/11=64 8/11=73	13/17=76	12/15=80	370- 399	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[a] for Six Activities	Comments
	Fort Smallwood Park	WD	2	2	NA	NA	2	2		Wind exposure could be a problem; larvae fetch on both shores but eastern shore is better protected because prevailing winds are from the northwest. Water and sediment quality are good.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	1-2	1	NA	2	2	1-2		
		SW	2	2	NA	1	2	2		
		O	2	NA	2	2	NA	NA		
		A	2	2	2	2	2	NA		
20		IP	1	2	2	2	2	2		
	Total		16/19=84	15/17=88	6/7=86	9/11=82	16/17=94	13/15=87	521-	
			17/19=89					14/15=93	532	
	Sparrows Pt.	WD	1		NA	NA	1	2		Poor choice--low environmental quality, privately owned, heavy ship traffic, and deep water.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	1		NA	2	2	1		
		SW	1		NA	2	1	1		
		O	1		1	1	NA	NA		
21		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		11/19=58		6/7=86	10/11=91	11/17=65	9/15=60	360	
	Fort Howard Medical Center	WD	2		NA	NA	2	1		Access may be restricted. Area is subject to NW winds. Polluted area. Water depth limits fish reefs - shipwakes may be a problem; however, shoreline appears clean. It has a beach.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	1		NA	2	1	1		
		SW	1		NA	2	1	1		
		O	2		2	2	NA	NA		
		A	1-2		1-2	1-2	1-2	NA		
22		IP	3		1	2	3	3		
	Total		12/19=63		4/7=57	9/11=82	10/17=59	9/15=60	321-	
			13/19=68		5/7=71	10/11=91	11/17=65	10/15=67	362	
	Stony Creek	WD	2	2	NA	NA	2	2		Many protected coves with existing wetlands and potential for more--Big Burley Creek is a potential wetland site. Water and sediment quality are good; wind exposure is not bad because of forests. There are some small piers but ship wakes should not be a problem.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	1	NA	1	1	NA	NA		
23		A	2	2	2	2	2	NA		
		IP	2	2	2	2	2	2		
	Total		17/19=89	16/17=94	5/7=71	7/11=64	16/17=94	14/15=93	505	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Enhancement Activities						Sum[a] for Six Activities	Comments
			Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs		
	Back Cove and Nabbs Creek	WD	2	2	NA	NA	2	2		Existing wetland is nice. There are some marinas that may inhibit fish reef development. Forest provides protection from erosion and runoff. Back Cove, Gambill Cove, and an unnamed cove are potential wetland sites.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1-2	2	1-2		
		O	1	NA	1	1	NA	NA		
24		A	2	2	2	2	2	NA		
		IP	2	1	2	2	2	2		
	Total		17/19=89	15/17=88	5/7=71	7/11=64 8/11=73	16/17=94	13/15=87 14/15=93	493- 508	
	Rock Cr. and Coves	WD	2		NA	NA	2	2		A diverse area--SAV, wetlands, beaches and wooded upland areas. Surf-side and Rock Creek estates have community owned shore areas which may be suitable for wetland construction, however, many recreational marinas in area so boat wakes may be a problem.
		WQ	3		NA	NA	3	3		
		SQ	3		NA	NA	3	3		
		WE	2		NA	1	2	2		
		SW	2		NA	2	2	1		
		O	1-2		1-2	1-2	NA	NA		
		A	2		2	2	2	NA		
25		IP	2		2	2	2	2		
	Total		17/19=89 18/19=95		5/7=71 6/7=86	8/11=73 9/11=82	16/17=94	13/15=87	414- 444	
	Sollers Pt.	WD	2		NA	NA	2	1		Water depth may limit fish reefs. Water quality and sediment poor. shoreline is riprapped; southeastern shore may be best for vegetation establishment because of wind exposure. Access limited.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	2		NA	1	2	1		
		O	1		1	1	NA	NA		
26		A	1		1	1	1	NA		
		IP	3		3	3	3	3		
	Total		13/19=68		5/7=71	7/11=64	12/17=71	9/15=60	334	
	Clements Cove and Peach Orchard Cove	WD	2		NA	NA	2	1		Publicly owned parks are in both coves. Clements Cove maximum depth is 10 feet which may restrict fish reefs. Most of the parks need improvement.
		WQ	1		NA	NA	1	1		
		SQ	1		NA	NA	1	1		
		WE	2		NA	1	2	2		
		SW	2		NA	1	2	2		
		O	2		2	2	NA	NA		
27		A	2		2	2	2	NA		
		IP	3		3	3	3	3		
	Total		15/19=79		7/7=100	9/11=82	13/17=76	10/15=67	404	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum(a) for Six Activities	Comments
			Enhancement Activities							
	Bullneck Cove	WD	2	2	NA	NA	2	2		Three publicly owned parks, one existing wetland, and many potential wetland sites. Water depth is appropriate for fish reefs and wetlands.
		WQ	1	1	NA	NA	1	1		
		SQ	1	1	NA	NA	1	1		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	2	NA	2	2	NA	NA		
28		A	2	2	2	2	2	NA		
		IP	3	3	3	2	3	3		
	Total		15/19=79	13/17=76	7/7=100	8/11=73	13/17=76	11/15=73	477	
	Lynch Cove	WD	2	2	NA	NA	2	1		Water depth is shallow except at mouth. Three parks. Water quality and sediment quality are poor. Erosion control is needed in some areas. Parks are heavily used.
		WQ	1	1	NA	NA	1	1		
		SQ	1	1	NA	NA	1	1		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
29		O	2	NA	2	2	NA	NA		
		A	2	2	2	2	2	NA		
		IP	3	3	3	3	3	3		
	Total		15/19=79	13/17=76	7/7=100	9/11=82	13/17=76	10/15=67	480	
	Head of Bear Creek	WD	2	2	NA	NA	2	1		Numerous private piers so ship wakes may be a problem. Areas of public lands. Country club is nice. Water depth for fish reefs is only suitable in channels.
		WQ	1	1	NA	NA	1	1		
		SQ	1	1	NA	NA	1	1		
		WE	2	2	NA	1	2	2		
		SW	1	2	NA	2	1	1		
30		O	2	NA	2	2	NA	NA		
		A	2	2	2	2	2	NA		
		IP	3	2	3	3	3	3		
	Total		14/19=74	12/17=71	7/7=100	10/11=91	12/17=71	9/15=60	467	
	Old Road Bay	WD	2	2	NA	NA	2	1		Polluted area--close to Sparrows Point. Many small wetlands and piers. Water depth for fish reefs is limited by proximity to shipping channels. Winds may be a problem on east side of bay. Ownership is private. Large mud flats.
		WQ	1	1	NA	NA	1	1		
		SQ	1	1	NA	NA	1	1		
		WE	1-2	2	NA	2	2	1-2		
		SW	2	2	NA	1	2	1		
		O	1	NA	1	1	NA	NA		
31		A	2	2	2	2	2	NA		
		IP	3	2	3	3	3	3		
	Total		13/19=68 14/9=74	12/17=71	6/7=86	9/11=82	13/17=76	8/15=53 9/15=60	436-449	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum(a) for Six Activities	Comments
			Enhancement Activities							
	Hog Neck	WD	2	2	NA	NA	2	2		Most of the shoreline is community owned. Water quality and sediment quality are the best in this outer harbor area. Water depth is appropriate for plants and fish. Wetlands exist and beaches are present. Improvement potential is low.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	2	NA	2	2	NA	NA		
32		A	2	2	2	2	2	NA		
		IP	1	1	1	2	3	2		
	Total		17/19=89	15/17=88	5/7=71	8/11=73	17/17=100	14/15=93	514	
	Fort Howard Park	WD	2	2	NA	NA	2	2		Publicly owned. Water depth appropriate. Wetland located inland. Water and sediment quality high. Potential for mitigation is high.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	2	NA	2	2	NA	NA		
33		A	2	2	2	2	2	NA		
		IP	2	2	2	2	3	2		
	Total		18/19=95	16/17=94	6/7=86	8/11=73	17/17=100	14/15=93	541	
	Shallow Creek	WD	2	2	NA	NA	2	2		Access may be limiting. Area is of high environmental quality--have to move offshore for fish reef building.
		SQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	1	NA	1	1	NA	NA		
34		A	2	2	2	2	2	NA		
		IP	1	1	1	1	1	1		
	Total		16/19=84	15/17=88	4/7=57	6/11=55	15/17=88	13/15=87	459	
	Black Marsh	WD	2	2	NA	NA	2	2		Access may be a problem. Environmental quality is high so improvement potential is low. Fish reefs may be successful offshore--low wake problems.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	2	NA	2	2	NA	NA		
35		A	2	2	2	2	2	NA		
		IP	1	1	1	2	2	2		
	Total		17/19=89	15/17=88	5/7=71	8/11=73	16/17=94	14/15=93	508	

TABLE A-1 (CONT.)

	Site and Ranking Criteria		Enhancement Activities: Wetland Construction	Wetland Rehabilitation	Shore Rehabilitation	Erosion Control	SAV Establishment	Fish Reefs	Sum[(a)] for Six Activities	Comments
36	Back Creek	WD	2	2	NA	NA	2	1		Access is good. Water and sediment quality are high. Ownership is primarily private. Water depth is shallow. A few private piers. Environmental quality is good.
		SQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	1	2	2		
		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	1	1	2	2	2	2		
	Total		16/19=84	15/17=88	5/7=71	7/11=64	16/17=94	13/15=87	488	
37	Main Creek	WD	2	2	NA	NA	2	2		Water depth is appropriate for both fish and plants. Good sediment and water quality. May be a ship wake problem for fish reefs due to marinas. Wetlands present.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	2	1-2	1		
		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	2	1	2	2	3	2		
	Total		17/19=89	15/17=88	5/7=71	8/11=73	16/17=94 17/17=100	13/15=87	502- 508	
38	Bodkin Creek	WD	2	2	NA	NA	2	1		Creek is shallow--may not be suitable for fish reefs. Wetlands exist. Water and sediment quality are high.
		WQ	3	3	NA	NA	3	3		
		SQ	3	3	NA	NA	3	3		
		WE	2	2	NA	1	2	2		
		SW	2	2	NA	2	1	1		
		O	1	NA	1	1	NA	NA		
		A	2	2	2	2	2	NA		
		IP	2	1	2	2	3	2		
	Total		17/19=89	15/17=88	5/7=71	8/11=73	16/17=94	12/15=80	495	

TABLE A-2 KEY TO NPDES PERMITS IDENTIFIED ON THE EXISTING CONDITIONS MAP DEVELOPED FOR THE BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN[(a)]

1. Pinehurst Harbour STP
2. Fort Smallwood STP
3. B.G.&E. Wagner Power Station
4. Cox Creek WWTP
5. Kennecott Refining Corporation
6. SCM Corporation
7. Cosmin Corporation
8. Chemetals
9. Pittsburg-Des Moines
10. Union Carbide Corporation
11. Harundale WTP
12. Dorsey Road STP
13. Hein Brothers
14. Sawmill Branch STP
15. ALCO Gravure
16. CM Kemp Corporation
17. Ralph L. Smith
18. Crown Central Petroleum
19. Olin Chemical Corporation
20. American Seamless Tubing Inc.
21. Maryland Steel Drum
22. American Oil Corporation
23. Farboil Company
24. Minerec Company
25. Central Oil Asphalt Corporation
26. M & T Chemical Inc.
27. Tenneco Chemical
28. Chevron
29. Joseph J. Hock
30. Denver Heat Treating
31. Keyston Automative Plating
32. Westinghouse ATL
32a. Adell Plastics
33. Armco Steel Company
34. Kaiser Aluminum
35. Proctor Silex
36. Moldform Plastics Inc.
37. Union Carbide
38. Solo Cup Company
39. St. Joseph Paper Co.
40. CGR Medical Group
41. Lenmar

(a) EPA (Segal et al. 1979) has published a list of 21 types of industries (by SIC Code) whose discharge causes the most environmental concern. With the exception of the storm water discharges at Sparrows Point, these SIC Codes were used to identify pollutant discharges.

42. Potlatch Forests Inc.
43. W. R. Grace Division
44. B.G.&E Gould Power Station
45. Proctor and Gamble
46. Allied Chemicals
47. American Can Company
48. Asarco Inc.
49. Agrico Chemicals
49a. Lebanon Chemicals
50. Bruning Plant
51. Cortlic Chemical Corporation
52. GAF Corporation
53. SCM Corporation
54. Western Electric
55. B.G.&E. Riverside Power Station
56. Riverside Synthetic Natural Gas Plant
57. Raymond Metal Products
58. Sparrows Point - storm water
59. Sparrows Point - storm water
60. Sparrows Point - storm water
61. Sparrows Point - rod and wire mill
62. Sparrows Point - hot forming
63. Sparrows Point - storm water
64. Sparrows Point (presently closed down)
65. Sparrows Point - storm water
66. Sparrows Point - storm water
67. Sparrows Point - storm water
68. Sparrows Point - storm water
69. Sparrows Point - electric generating plant
70. Sparrows Point - storm water
71. Sparrows Point - garage and boiler room

APPENDIX B:

PRELIMINARY COST ESTIMATES FOR THE FIVE SITES SELECTED FOR CONCEPTUAL SITE PLAN DEVELOPMENT

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 1 CONCEPT PLAN

ITEM	QUANTITY	UNIT	UNIT PRICE	COST
Supplement Existing Bulkhead w/ Riprap *1	2,856	L.F.	$ 6 - 8	$ 17,136- 22,848
Supplement Existing Stone w/Riprap *1	500	L.F.	20 - 25	10,000- 12,500
New Stone Breakwater *1	2,450	L.F.	45- 50	110,250-122,500
Regrade Shoreline	162	Cu.Yd.	5	810
Fill *2	9,556	Cu.Yd.	8- 10	76,448- 95,560
Marsh Seeding	2.3	Acre	6,000-10,000	13,800- 23,000
Shoreline Clean-up *3	1,200	L.F.	5	6,000
Fish Reef	No data readily available at this writing			
			SUBTOTAL	$234,444-283,218

*1 Water depths and energy conditions of the shore must be determined to accurately estimate amount of riprap needed.

*2 To determine fill, existing water depths were estimated from navigation maps. No exact measurements were taken.

*3 Length of shoreline to be cleared was estimated from field visit. No exact measurements were taken.

Note: Water depths for south wetland were estimated to average 2'.
Water depths for western wetland were estimated to average 4'.

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 2 CONCEPT PLAN

ITEM	QUANTITY	UNIT	UNIT PRICE	COST
Stabilize Eroded Bank, Regrade *1	500	Cu.Yd.	$ 5	2,500
Hydroseed With Wood Fiber Mulch Added *1	2,000	S.Y.	.57	1,140
New Stone Breakwater Off Shore *2	4,750	L.F.	78- 85	370,500-403,750
New Stone Breakwater at Pier *2	2,000	L.F.	228- 266	456,000-532,000
Fill *3	70,664	Cu.Yd.	8- 10	565,312-706,640
Marsh Seeding	10.0	Acre	6,000	60,000
Fish Reef	No data readily available at this writing			
			SUBTOTAL	$1,455,545-1,706,030

*1 Amount of shoreline to be regraded and reseeded estimated from field visit. No exact measurements were taken.

*2 Water depths and energy conditions of the shore must be determined to accurately estimate riprap quantities.

*3 To determine fill, existing water depths were estimated from navigation maps. No exact measurements were taken.

Note: Water depths for off shore wetland were estimated to average 3.5'.

Water depths for wetland around existing pier were estimated to average 6'.

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 4b CONCEPT PLAN

ITEM	QUANTITY	UNIT	UNIT PRICE	COST
Clean & Remove Debris from Existing Culverts	NA	NA	$2,500-3,000	$2,500-3,000
Establish Submerged *1 Aquatic Vegetation (SAV)	1.1	Acre		20,000
			SUBTOTAL	$22,500-23,000

*1 Cost depends upon availability of SAV and location of the bed.

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 5 CONCEPT PLAN

ITEM	QUANTITY	UNIT		
Excavate Pond, Stockpile & Relocate Soil on Site	49,360	Cu.Yd.	$ 5	$246,840
Stone Breakwater *1	1,845	L.F.	200- 400	369,000-738,000
Fill *2	48,484	Cu.Yd.	8- 10	387,872-480,484
Marsh Seeding	9.2	Acre	6,000	55,200
Shoreline Cleanup *3	600-900	L.F.	5	3,000- 4,500
			SUBTOTAL	$1,061,912-1,525,024

*1 Water depths and energy conditions of the shore must be determined to accurately estimate amount of riprap needed.

*2 To determine fill, existing water depths were estimated, no exact measurements were taken.

*3 Length of shoreline to be cleaned was estimated from field visit. No exact measurements were taken.

Note: Water depths were estimated to average 15'.

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 3 CONCEPT PLAN

ITEM	QUANTITY	UNIT	UNIT PRICE	COST
Stabilize Eroded Swale, Regrade *1	73	Cu.Yd.	$ 5	$ 365
Hydroseed with Wood Fiber Mulch Added *1	156	S.Y.	.57	89
New Stone Breakwater *2	1,500	L.F.	45- 50	67,500- 75,000
Fill *3	4,840	Cu.Yd.	8- 10	38,720- 48,400
Marsh Seeding	1.5	Acre	6,000-10,000	9,000- 15,000
				$115,674-138,854

*1 Amount of shoreline to be regraded and reseeded was estimated from field visit. No exact measurements were taken.

*2 Water depths and energy conditions of the shore must be determined to accurately estimate amount of riprap needed.

*3 To determine fill, existing water depths were estimated from navigation maps. No exact measurements were taken.

Note: Water depths were estimated to average 4'.

BALTIMORE HARBOR ENVIRONMENTAL ENHANCEMENT PLAN
REGIONAL PLANNING COUNCIL
PRELIMINARY COST ESTIMATE
SITE 4a CONCEPT PLAN

ITEM	QUANTITY	UNIT	UNIT PRICE		COST	
Excavate and Remove Soil 60' by 12' wide.	69	Cu.Yd	$ 10		$ 690	
Construct Channel with Stone Riprap	60	L.F.	30-	35	1,800-	2,100
Contruct 2 Stone Jetties with Riprap *1	23	Cu.Yd.	50-	60	1,150-	1,380
Wooden Foot Bridge	25	L.F.	300		7,500	
Fish Reef	No data readily available at this writing					
			SUBTOTAL		$ 11,140-	11,670

*1 To determine amount of riprap, water depth was estimated from navigation maps. No exact measurements were taken. Energy conditions of the shore must be determined to accurately design stone jetties. Length of jetties estimated to be 25' in length.

Note: Water depth was estimated to average 2'.